IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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COMING MEETINGS AND PAPERS

PITTSBURGH SECTION

W. E. Miller, Chairman

R. B. Davenport, Vice Chairman
R. F. Chaffin, Past Chairman
A. A. Stewart, Papers
R. M. Hussey, Membership
T. E. Hughes, Meetings
J. S. Murray, Reception

Saturday, December 17th, 1927

2:30 P. M.

Blue Room, William Penn Hotel — Pittsburgh. Pa.

"GENERAL IDEAS AND DISCUSSIONS"

Auspices New Developments Committee

Mechanical—J. F. Spellacy, Chairman.
Electrical—J. S. O'Donovan, Chairman.
Combustion—Walter Flanagan, Chairman.
Safety—Walter Greenwood, Chairman.

"Every active and associate member is invited to contribute a discussion on some new development or new practice."

7:00 P. M.

"Annual Christmas Party"

Thursday, January 19th, 1928 (All Day Session)

Blue Room, William Penn Hotel — Pittsburgh. Pa.

TOPICAL DISCUSSION

"DOES GROUNDING THE NEUTRAL REDUCE APPARATUS TROUBLES."

10:00 A. M.

"The Theory of Grounding."
"The Effect of Grounded Neutral on the Efficiency of Lightning Protection Equipment."
"The Effect of Grounding on the Reliability of Relay Operation."

2:00 P. M.

"The Effect of Grounding on Telephone Interference."
"Experience with Equipment When Operating With Neutral Grounded."

Thursday, February 24th, 1928 (All Day Session)

"TOPICAL DISCUSSION COVERING INSULATORS."

Blue Room, William Penn Hotel — Pittsburgh. Pa.

"Topical Discussion Covering Insulators."

10:00 A. M.

"Mechanical Design." "Protection from Flashover." "Overhead Ground Wires."

2:00 P. M.

"Effect of Dirt on High Voltage Insulators." "Insulator Hardware."

"Exhibit of High Tension Insulators by Various Manufacturers."

BIRMINGHAM SECTION

Saturday, November 26th, 1927

"Roller Motor for Steel Mills," by A. M. MacCutcheon, Engineering Vice President, Reliance Electric & Engineering Company, Cleveland, Ohio.

Saturday, January 26th, 1928

"Automatic Screw Downs," by G. E. Stoltz, Industrial Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

PHILADELPHIA SECTION

George J. Walz, Chairman — Linn O. Morrow, Secretary

Saturday, December 3rd, 1927

"Topical Discussion On Grounding."

CHICAGO SECTION

Edwin L. Upp, Chairman — Gordon Fox, Secretary

November 15th, 1927

"Inspection Trip to Delta Star Electric Company."

Papers

"Outdoor Sub-station Design," by R. E. Anderson.
"Spacing of Low Voltage Cables," by W. H. Boyce.

CLEVELAND SECTION

G. A. Lamberton, Chairman. — A. R. Lintern, Secretary.

Friday, December 2nd, 1927

Inspection Trip

National Carbon Co., Cleveland, Ohio.

EDITORIALS

INSPECTION TRIP
GARY TUBE COMPANY, GARY, IND.

Thursday, October 20, 150 engineers of the Chicago District paid a visit, in the form of an inspection trip, to the Gary Tube Company located at Gary, Ind.

The Tube plant is one of the latest built by the National Tube Company under the personal supervision of F. R. Waterman, who is the present General Manager of Works.

This plant is laid out with a view of future developments and there is very little, if any, duplication of material handling so common in the old style plants.

One very noticeable improvement in plant design is the manner in which the maintenance shops are located. Usually Maintenance Shops are given very little, if any, concern when plants are designed and erected. However, at the Gary Tube Company, all of the shops are so located that repairs, when necessary, may be made in a minimum amount of time and, of course, economically. An operating engineer or maintenance superintendent receives a real thrill in a visit to the Gary plant.

The Skelp Mills are equipped with all of the latest and most modern devices, calculated to produce tonnages far in excess of the old style mills.

The Seamless Tube Mills and the Lap and Butt Welding Furnaces at this plant are also of the most modern types and hold many tonnage records.

The Galvanizing Department created a lot of interest as there are many ingenuous devices for handling pipe in this department.

Another very interesting feature enjoyed by the engineers who visited this plant was a machine located in the Coupling Tap Department. This machine is something new—it insures perfect threads in couplings and is used by the Inspection Department to make sure that no couplings are shipped unless they are perfect ones. It may be said in this connection that all of the pipe receives a most rigid inspection before shipment.

The electrical installations at this plant reflects the management's attitude for modern equipment throughout. It might also be said that this is a completely electrified plant.

In going over this works the engineers could not help but notice the many devices that have been installed for the welfare, comfort and care of the employees. Cleanliness must also be the motto at this plant as there was no dirt, no grease, and an abundance of light and ventilation. The hazards in this plant seem to be few and far between.

After the inspection trip the visitors adjourned to the new Gary Hotel where an elaborate dinner was served. After the dinner, a technical session was held at which time Edwin L. Upp, Chief Electrical Engineer at the Gary Tube Company presented a paper covering the electrical installations at the Gary Tube Plant.

The Association of Iron and Steel Electrical Engineers takes this opportunity of expressing its appreciations to the officials of the Gary Tube Company who permitted the inspection and particularly to Mr. Waterman, Mr. Upp and Mr. Booth, whose untiring efforts made the trip such a success.

MEETING OF THE ELECTRICAL HEATING COMMITTEE

The Electrical Heating Committee headed by Mr. George H. Schaeffer, Chairman, who is the Electrical Engineer at the Carpenter Steel Company, Reading, Penna., met September 21st, 1927, at Detroit, Mich.

This Committee is one of the most active functioning committees of the Association of Iron & Steel Electrical Engineers and the membership of the Association will enjoy for some time in the future editorials covering present practices in the Electrical Heating Field.

Among the various subjects discussed, Bright Annealing, Heat Treated Rails, Atomic Hydrogen Welding, Electric Spot Welding, Arc Welding, High Temperature Furnaces, Induction Melting Furnaces and Low Temperature Furnaces received the major amount of attention.

One interesting feature brought out was the fact that there were now heating units on the market that ran as high as 2800° F. However, it was claimed that in this connection the life was short.

One very interesting point brought out in the discussion at Detroit was that we analyze heating costs in per cent of the total cost of the product and balance against the improvement of the quality. It was brought out in the discussion that it is not the cost of electric heating, it is the cost of heat treating that is the important feature. Heating costs only one-half per cent of the total cost.

The Electric Heat Committee will meet from time to time to discuss the experiences secured in the field of operation. They also invite the membership to present their problems to this Committee.

DOES PIECE RATES ENCOURAGE QUALITY WORKMANSHIP IN ELECTRIC MAINTENANCE SHOPS?

A number of years ago one of the prominent members of the A. I. & S. E. E. presented a short discussion in connection with piece rates in electrical maintenance shops.

At that time many of the engineers in the Steel Industry felt that this was a radical step in quality production workmanship. However, since that time, quite a number of electrical engineers have adopted a piece rate system in their maintenance shops and their experiences so far have been that it is possible to produce quality workmanship in maintenance shops using the piece rate system.

It must be realized that there is a vast difference in the relation between piece rates or bonus systems in mass production and maintenance shops.

Some time in the future, papers will be presented before the membership of the A. I. & S. E. E. presenting the results obtained in the shops using piece rate systems.

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Main Drives 10" Merchant Mill at McKinney Steel Company

By A. F. KENYON*

DURING the past few years remarkable advances have been made in rolling mill design. These improvements have made it possible to roll a wider range of sections in one mill while at the same time producing greater tonnages with less operating labor and expense. The increased output with reduced labor has been due largely to greater flexibility of the mills and reductions in the time required to change from one rolling schedule to another. Greater flexibility has been secured in most cases by more intensive application of the characteristics of the electric motor to the needs of the particular mill.

Last October the McKinney Steel Company placed in operation an electrically driven 10" Morgan merchant mill which has been designed to roll a wide range of product and to have a high monthly output. To roll successfully on a mill of this type it is necessary to be able to adjust the speed of the main motors over a wide range and to have easy control of the speed at any point in the range. For this reason direct current adjustable speed motors

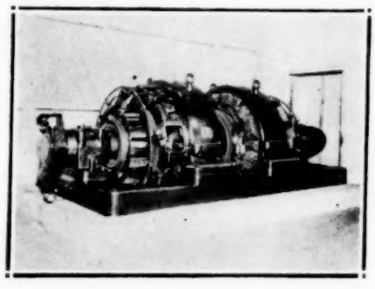

FIG. 1.

with close inherent speed regulation were selected for the main drives of this mill. The method of securing good inherent speed regulation is one which has not been employed heretofore and this, together with other features of the main drive, make the electrical intallation an interesting one.

The mill has a roughing train driven by a 1000 hp., 200/600 rpm. motor, an intermediate train driven by a 2000 hp., 137/275 rpm. motor and four finishing stands driven by a 1200 hp. 300/550 rpm motor. On account of the wide speed range and comparatively large size of the 1000 hp. motor, the best performance was obtained by building this motor as a double armature machine. Each armature is wound for 300 volts and the two are connected in series across the 600 volt line. The shunt and series fields are connected in series across their respective exciters in the same manner. The 2000 hp. and 1200 hp. motors are both single armature machines. Figures 1, 2 and 3 show the motors in operation.

*General Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Speed adjustment is entirely by field control of the motors; the generators being flat compounded to maintain constant potential of 600 volts from no load to full load. All motors are equipped with compensating pole face windings. The shunt fields of the motors and generators are supplied from a 250 volt exciter direct connected to the main synchronous motor-generator set. Compounding of the

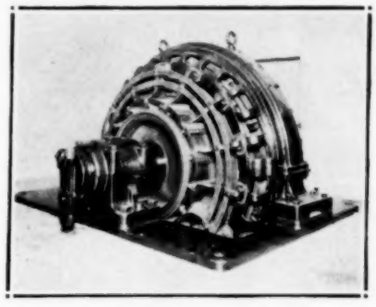

FIG. 2.

motors is secured by means of a shunt type winding energized from a series exciter which has its field in series with the main armature lead.

The use of the compensating winding greatly extends the commutation and speed regulating performance of a direct current motor. Its use flattens out the speed curve, particularly on heavy overloads, and by proper proportioning of the compounding of a compensated motor the change in speed when full load is applied can be reduced to a very small value.

Alternating current power is supplied to the mill at 6600 volts, 3 phase from the Company's 25 cycle power system. Synchronous motor-generator sets lo-

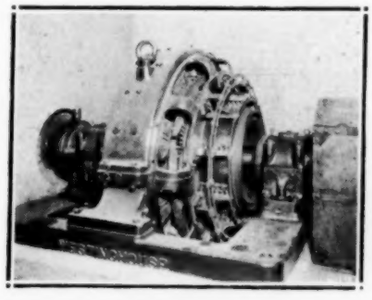

FIG. 3.

cated in the mill substation convert the 25 cycle power to direct current at 600 volts for the main drives and 250 volts for the auxiliaries.

The constant speed compensated motor can easily have its series field adjusted to give a practically flat speed curve at any one speed over a wide range of load. However, a motor to operate over a 2 to 1 or a 3 to 1 speed range, has a strong shunt field at

low speed and a weak shunt field at maximum speed; so compounding to give flat speed regulation at low speed would give very poor regulation at maximum speed. One scheme which has been employed is to use knife switches or magnetic contactors to shunt varying amounts of current around the series winding at different parts of the speed range. Where very fine regulation over a wide range is required, this scheme necessitates a number of shunting switches

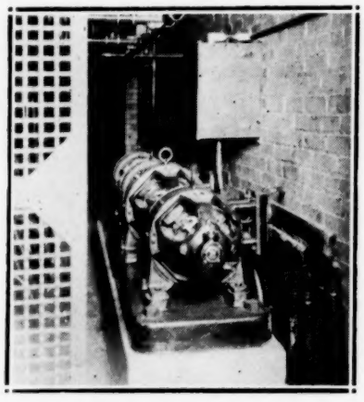

FIG. 4.

and it is necessary to operate one of the switches each time the shunt field current is varied any appreciable amount.

It is evident that if the series field strength were changed each time the shunt field strength is changed to secure speed adjustment, it would be possible to secure flat speed regulation at any point in the speed range of the machine. This continuous adjustment of the series field has been secured by means of a series exciter and a series field rheostat, mechanically connected to the shunt field rheostat, with resistance in the series field rheostat proportioned so that for every value of shunt field excitation and motor speed the correct compounding for best speed regulation is obtained. The combined rheostat consists of two

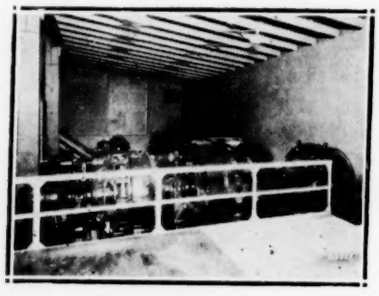

FIG. 5.

face plates mounted back to back, connected to the same shaft and operated by a small motor through reduction gearing. The correct value of resistance in the series field rheostat is determined by actual load tests in the shop. Figure 4 shows the series exciter set in place behind the motor starting panels.

DC power for the main drives is supplied by a 2500 kw. synchronous MG set consisting of 2-1250 kw., 600 volt, 750 rpm. compound compensated generators; a 3660 hp. 6600 volt, 3 phase, 25 cycle, 4 pole, 750 rpm., unity power factor synchronous motor and a 250 volt direct connected exciter. A duplicate 2500 kw. set is installed in the same room and will be used to supply a 12″ merchant mill. Under normal conditions each MG set will operate on its own

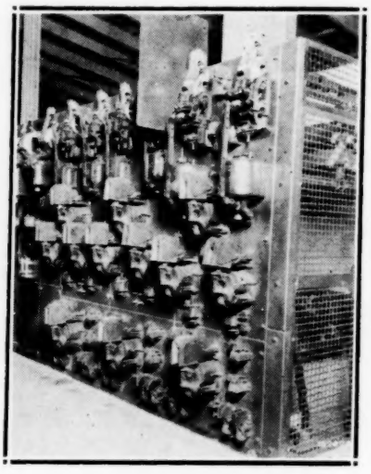

FIG. 6.

600 volt bus. Each generator is separately connected to the bus and in case of damage to one generator, the 10″ mill and 12″ busses can be paralleled and the 3 remaining generators used to carry the combined load of both mills. Figure 5 gives a view of the motor-generator sets.

Any motor can be started independently by means of a magnetic contactor type controller. Each controller gives dynamic braking in the off position.

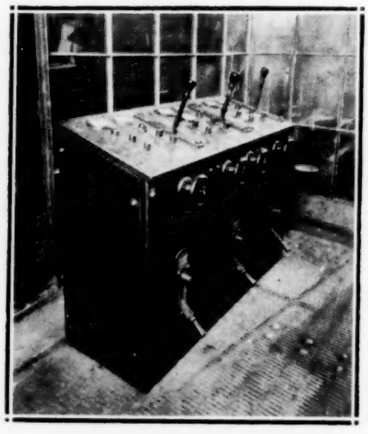

FIG. 7.

Complete control of the motor is centralized in a control desk mounted in the mill pulpit. On this desk are mounted the start and stop push buttons for the main motor, "Fast" and "Slow" push buttons for regulating the speed, instruments for indicating the load and speed of each motor, signal lights to indicate the position of the main contactors, and a vernier rheostat operating handle used in making fine adjustments of speed. The starting

panels are shown in Figure 6 and the desk in Figure 7.

Experience with this installation has demonstrated the flexibility of the drive and the method of control. The operator is able to set the speed to the proper value when the mill is operating light and the only adjustments required after rolling starts are those necessary to compensate for heating of the motor fields and slight irregularities in the steel itself, caused by change in temperature of the furnaces or change in adjustment of the rolls. In case of a cobble only that part of the mill which is in trouble need be stopped and as soon as the cobble is cleared away this section can be started and will come up to the speed which was being maintained before the accident.

*General Ideas and Discussions**

Prepared by Philadelphia Section A. I. & S. E. E.

F. O. Schnure†, Chairman: The meeting tonight has been set aside for general ideas and discussion. It has been our practice in the past to give each member an opportunity to express at this time, ideas which were not covered by the papers that were previously discussed during the year. It is a sort of an open meeting, and everybody should feel free to bring up any subject they wish, or present any idea that has been of value to the industry during the past year. Since we did not receive any large number of responses from members volunteering papers, we will have to ask everybody to come across tonight with something.

Coming up on the train this afternoon I set down some subjects that can be discussed extemporaneously by practically every man here, so if any of you do not have a subject, one can be chosen from the following:

Fuses vs. Circuit Breakers.
Electric Welding.
Manual vs. Magnetic Control for Cranes
Piece rates for Electric Repair Work.
Industrial Heating.
Elect. Locomotives and Motor Cars.
Proper Motors to Apply to Waste Heat Fans and Fans on Boiler Installations.
Powdered Coal Installations.

We are putting a powdered coal installation in at Sparrows Point on two 150,000 lb. per hour steam generators, and two 1291 H.P. boilers and we have been interested in the problems connected with powdered fuel from an electric standpoint. Then we have recent developments in mill drives and we have the electric flying shears or rotary shears.

We have developed in this country two electric shears, but neither of them are operating yet. One is to be used, I believe on a small Skelp Mill. The electric development on this shear was done by the Westinghouse Company. The other flying shear goes to our plant at Sparrows Point, and was developed electrically by the General Electric Company. The principle in each case is about the same, different methods being used to accomplish the same end. We also hear a good bit about continuous sheet mills, but I guess there is not much written or discussed on this subject. Other subjects include:

Roller Ball Bearings vs. Sleeve Bearings
Oil Circuit Breaker Development.
Shop Practices.
High Voltage Switching Practices.
Switchboards Having Automatic Reclosing Feeders.
Lubricating Systems.

And there are lots of other problems I have not even touched on.

In opening this meeting I would like to call on Mr. Burr for whatever he may have to tell us regarding any of these subjects.

Walter H. Burr*: I did not come prepared with any set speech tonight, but there are several questions I want to ask and see if I can get information from some of the representatives of other steel mills, who perhaps have more information on these topics than I have.

I would like to ask the representative of the Bethlehem Steel Company, at Bethlehem, whether they are using in their electric repair shop piece rates or bonus system on straight machine work. Any information which they can give on shop methods I will appreciate very much.

Then there is the question of getting the repair parts which are machined, armatures and spare motors, etc., to the various mills where they are to be used. In other words, the transportation of the material from the electrical shop to the various departments is a question which is receiving some attention at our plant and on which I would like to have some discussion. We are using at the present time a narrow gauge electric locomotive, which we have in our possession, but which seems to be rather difficult tto keep in our possession. As soon as the other departments find their locomotive is not available they appropriate ours and it is not in its proper place when we want it on all occasions.

Electric welding is a subject which I would like to have some of the other superintendents discuss: Is the electric welding under the electrical department, or is this part of the work handled in a welding department where the gas welding is carried on?

I would also like to have information from some of the other men here tonight with reference to their method of handling the reports on condition of electric equipment; that is, how information gathered by the repairmen on the cranes and auxiliary mill mo-

*Presented before Philadelphia Section, April 2nd, 1927.

†Elec. Supt., Bethlehem Steel Co., Sparrows Point, Md.

*Supt., Elec. Dept., Lukens Steel Co., Coatesville, Pa.

tors and controls is turned in to the Electrical Department.

I think perhaps these questions will start the discussion, and if I can get some information on some of these points, I will think my time well spent in coming here this evening.

George J. Walz*: In regard to Mr. Burr's question of handling spare parts around the mills, we have gone through quite a variety of experience with this: The first thing we did was to buy a big, expensive gasoline truck, having a capacity of 3 tons and costing several thousand dollars. We have tried electric storage battery trucks whose first cost as well as whose battery maintenance is high. Our next move was to buy a Fordson tractor, with special wide tread, large diameter driving wheels which cost us $670 and is driven by a cheap boy, and one trailer for each group of mills which the tractor is intended to serve. Our practice is to leave a trailer at the Open Hearth, one at the Rolling Mills, etc., and as the damaged motors, controllers and parts—that is parts that have worn out or have been burned up—come out of service they are placed right on that trailer, and some time every day this tractor comes around and picks up all these trailers taking them directly to the electrical repair shop in one trip, and later on takes out and distributes the repaired material on the outgoing trip. We run that tractor to death in about two years, and then get about a 50% trade-in allowance on it. This we have found to be the best system for handling spares and repair parts.

Mr. Schnure has read off quite a number of subjects for discussion, all closely related to the whole steel mill electrical game, but there are one or two questions I would like to have him answer for me. One is what the operating record has been on his A.C. adjustable speed brush-shifting shunt motors driving waste-heat boiler fans. We are almost to the point where we will have to put in a few more of these fans at our plant, and I would like to know what luck he has had with these special motors.

And, since he has been asking so very many questions himself, there is another question I would like to ask him—whether any of those synchronous motors have been put on the main-roll mill drive which he told us about some time ago and what his operating experience has been with those motors.

F. O. Schnure: I will answer my part as they come along. The BTS motors have been working for eight months. One furnace has gone through a cycle, and we have kept a record to determine how the Open Hearth handled that fan. We have observed one thing, that is, the speed does not vary very much from one end of the furnace life to the other. The horsepower goes up, but in our particular case the speed is around 400/450 RPM. We have had no trouble with the motors, they run along very nicely. If one knew exactly just what a furnace was going to require, a fan could be built to handle the maximum products of combustion when operating at any desired a.c. synchronous speed. In such a case you could buy a constant speed motor. We have occasionally run those fans above 500 RPM. These fans are on fire tube boilers and when we started the boilers were not cleaned regularly and there was a heavy draft loss. We then had to run the fan above synchronous speed at about 525 RPM to get the volume, but after a good bit of discussion between the Open Hearth men, and the boiler men and the engineering department, it was found the tubes had to be cleaned every day, and after this was done the motor speed was dropped materially.

Now, I will say this, if you know exactly what the furnace is going to require you can possibly buy a fan at the right speed to do that work, but, if you do not know, then your BTS or adjustable speed motor comes in very nice.

Referring to Mr. Walz' question on synchronous motors, we do not have them installed yet.

Mr. Walz mentioned his transportation facilities. I would like to ask a question. Suppose the Open Hearth calls for an armature, how do you take it out?

George J. Walz: From stock. We carry a few armatures in the Open Hearth for emergencies. When the mill electricians do need something from the main electrical storehouse for an emergency, they call up the storekeeper and he gets in touch with the boy who drives the tractor, who then delivers the material at once. He does this in addition to his regular routine of work.

F. O. Schnure: We have a 3½ ton truck with a winch on it, which comes in very handy. We don't as a rule carry spare armatures, except in some of the mills. It is a Packard 3½ ton truck.

George J. Walz: The advantage of a Fordson is, you can go through a lot of places around a mill which a regular truck will not do.

F. O. Schnure: It seems advantageous to let the trailer stand and let the fellows load up their stuff. I might state that our Packard is nine years old and has been running day and night.

Who is prepared to take up piece rates? I will call on Mr. Dawson.

T. C. Dawson*: We use piece rate on straight machine work. We are also using it on armature winding and bench repairs, in fact all over the shop with the exception of Bull Gang work and electric welding. We have had piece rate since last September and so far it has been satisfactory, although some rates have had to be adjusted as we were bound to make some mistakes in rate setting at the outset.

About three years ago we stopped using soldering irons in our repair shop; since that time we have been using torches with a combination of City gas and oxygen with very satisfactory results. In soldering the larger types of bar wound armatures with irons we found the winder did not always get the solder down to the base of the bar. The front of the bar would be smeared with solder and there was no way of knowing if the bar was fully soldered. In using the torch, we apply the heat at the base of the bar and feed the solder from the top. The heat must therefore carry up through the bar to melt the solder. The solder will then run down and fill the entire slot with solder. When a drop of solder appears at the bottom the winder is sure the slot is full. The flame is applied at an angle to the bar, thus preheating the next bar to be soldered and mak-

*Asst. Supt., Elec. Dept., Bethlehem Steel Co., Steelton, Pa.

*Electrical Dept., Bethlehem Steel Co., Bethlehem, Pa.

ing a quicker job as the bar is ready in a few seconds' time after the heat is applied directly to it.

On the smaller sizes of wire wound armatures we apply the heat at right angles to the bar and about one quarter of an inch in front of the riser. After the first few bars are heated the winder can then solder as fast as he can turn the armature with one hand and rub the bar of solder over the riser.

We also use these torches for stripping the armatures. The winder cuts the coils off back of the risers with a chisel and pulls them from the slots. He then cleans the leads out of the risers with the torch. After the armature is stripped a clean coat of tin can be applied and excess solder removed from the risers in the following manner. Place a piece of asbestos board between the back of the risers and core to act as a shield. Heat up the risers with the torch and blow out the excess solder with an air hose, alternately apply the torch and hose. This leaves a clean, well tinned riser for rewinding. In this operation the winder should wear goggles to protect his eyes from small particles of solder which may rebound from the asbestos. By using a larger nozzle on the torch, the winders also can apply heat to a commutator refilled with new mica and draw it up tight.

On the incoming City gas line, water seals should be provided. In case of pressure failure on the gas line the oxygen might pass back into the gas mains and form an explosive mixture.

The oxygen we use in tanks with regulators on each tank. We find three tanks to be sufficient for seven winders. In the beginning we had a pipe line run along side the benches but found the oxygen was hard to confine and leaked away rapidly. With individual tanks this loss is reduced to a minimum.

We have found that our soldering time has been cut in half for all types of armatures and we are also sure of a well soldered job with this method.

F. O. Schnure: We have piece rates at Sparrows Point. We started on armatures in 1923, and we have expanded it to cover winding magnets, field coils, controller parts and a good bit of standard machine work such as boring out bearings, turning track wheels and turning up shafts, although we are not 100%. I think the Saucon Plant started piece rate system about one year ago. Every bit of work in that shop is done on piece work, even to the tearing down of motors, I believe.

A Member: How do you handle your inspecting? Do you have an inspector take care of your armatures, and do you put a penalty on the failure of an armature?

F. O. Schnure: We have a gang leader in our armature winding department, and when he saw the men making more money he wanted to wind armatures himself. As a matter of fact he winds armatures and looks after the work also. We have very few troubles we can trace to poor workmanship due to the piece work system. When we do have any work fail on piece work, we make that fellow do it over on straight time, when we can trace it. They consider that quite a penalty. I think you can count that phase of the piece rate system as being negligible. Of course the work is inspected by the gang leader in charge of that division. As I stated before, he is a working gang leader. We did away with the overhead of a gang leader on this particular job.

John McTamney*: Mr. Burr brought up the question of electric welding versus acetylene. There is a big field for both, but in most cases there is a great deal of welding being done by acetylene that could be done to better advantage with the electric arc.

In our plant we started in the electric welding game for our own repair work, such as building up worn armature shafts and etc. The balance of welding was being done by acetylene, however, within the past few years, our electric welding has grown, and has become so successful that the Department that has charge of acetylene welding has turned over the majority of their own welding requirements to us.

Mr. Burr also brought up the question, if the Electrical Departments should have charge of electric welding. In our Plant the electric welding comes under the Electrical Department, and to my mind this is the ideal condition to have.

Mr. Burr brought up the question of armature work being done on piece work. We had a piece rate in force some ten years ago in our Plant, but I am afraid it was a piece rate in name only. Mr. Schnure spoke about penalties on piece work. It is a fact that defects do exist on piece rate work, and it might be stated the men rewind the defective armatures on their own time, but this is some proposition. In regard to inspection of armatures, which one of the members asked about. All our repaired or rewound armatures are inspected and tested by a man other than the one who made the repair. This record as well as the record of repair and man's name who made the repair is kept on file, so that we may have complete history of each armature. All armatures are given a number, this number being stamped on shaft when when armature is received in repair shop. A repair card is made out for same; this card follows armature through shop until it is tested and put on duplicate rack, when card is filed.

Regarding inspection of electrical work in field, which one of the members brought up. The Electrical Department in our Plant has charge of Mechanical work as well as electrical work on cranes. The inspection and repairs of cranes is kept separate from work on the floor, such as mill motors, machine tool motors, etc., as we feel the nature of work on these two lines is very different. On cranes you require men with more mechanical ability than electrical, and on floor work it is the opposite, especially in a plant such as ours, where we have a great deal of automatic control on machine tool work.

The inspection of work in the field is handled by men making out inspection sheets, and turning same over to their foremen.

Walter H. Burr†: The method employed at Lukens is very similar to what has just been outlined. We have eight (8) foremen in various parts of the plant, but we differ from the practice at Midvale, in that the gangs that take care of the cranes also have to take care of the motors on the ground. The inspection reports do not come signed by each inspector, but reports come in daily to my office from the foremen of the different divisions. The foreman's report states what repairs have been made by

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his men, and what material is needed to make repairs to other equipment. The system of keeping armature records is not the same as outlined at Midvale, but the final results are practically the same. We keep a complete record of every armature and field frame from time of purchase to present time, and a report of repairs made, whether under repairs or in operation, and location at the present time.

F. O. Schnure: At Sparrows Point, the night men have a plain sheet of paper and they make a record of any serious trouble they have had. The foreman comes along the next day, takes a look at it and goes after the work with his day gang. The general foreman sees it is finally done.

On armatures we keep a record according to the serial number of the armature. At the end of the month the records show the number of armatures coming from each mill.

R. F. Gale*: One of the principal reasons for keeping the floor motors and overhead motors separate is because in Midvale we have eight machine shops, and some of the drives are much more complicated than others. It would take too much time away from the crane men, and Mr. McTamney found he could save money and get better results by educating the men on the shunt and compound motor drives to better advantage than by trying to force a man to take care of the overhead series motors as well as the constant speed motors, etc.

We used to have a printed report, and it would read something like this: "Mr. ——— (the head of the electrical department), please note the following is the condition of and repairs needed to." This of course was filled out, and we found that maybe the inspection was not religiously lived up to, and it used up so much paper that we drifted back to the general blank sheet, which seems to work out better than trying to tell how the report should be written.

The inspection of overhead cranes has of late been extended, due to risks of accidents from material falling off, and we for the past year have been especially active in trying to prevent things from falling off of cranes. We had quite a crusade about a year ago to clean everything off cranes. I do not mean parts of cranes falling off due to failures, but it seems to be the general tendency of a fellow when using nuts, bolts, chisels, sledge hammers, etc., to leave some on the girders or foot walks, and the first thing you know down they come, and if some fellow happens to be walking along at that particular time an accident occurs. Cranes can be thoroughly cleaned of loose material, but tomorrow a board or something that will fall down is found.

Our problem was to decide on whom this particular responsibility rests, and see that he assumes it. Our activities toward safety brought out one important thing, viz., the crane operator is absolutely blind to anything except the control handles. We have directed an educational campaign toward each and every operator, so that when he goes on a crane he not only looks it over to see if anything has been left there liable to fall, but at the time looks up at the ventilators, footwalks or the steel work of the shop to see whether there is a tie rod parted, or something is likely to fall. We have received much co-operation along this line. At various times a foreman goes on a crane as a check, and sees something loose which is liable to fall, and says to the operator: "Have you looked over your crane?" "Yes." "And is everything all right?" "Yes, sir." "How about that part up there?" "It wasn't there yesterday." "Well, it is there today. You have been operating this crane for five or six hours, and you know you are not to operate until this is removed." Under such conditions the operator is sent home for the rest of the day.

However, another man is involved—the man who inspects and repairs the crane. Shall we hold him responsible as well? He is supposed to be on every crane once in twenty-four hours, and we do not accept any excuses for his not being there.

One of the hardest things Mr. McTamney has to settle is the dispute between the operator and the inspector. The crane operator blames the inspector, and the inspector lays the blame on the crane operator. We have impressed the inspector with the fact that he is at perfect liberty to take the crane operator by the neck and throw him off, if he is guilty of an infraction. We make it just as easy as we can for him in getting results. I cannot consider anything more dangerous than an overhead traveling crane.

There is, however, another phase to the situation. If something does happen to fall off a crane, and the matter comes to the Engineering department's knowledge in any other way before the repairman comes and confesses, the men involved lose time because they neglected to notify their headquarters first.

A few days ago a shoe fell off a crane in the stock yard. It happened about four o'clock in the afternoon. The crane operator knew it fell off, and a man on the ground from another department picked it up and took it to the repair shop. The crane could not run until that was fixed. Somebody stole that shoe from the repair shop and gave it to the safety department. The repairman took another shoe and got the crane running. But neither he nor the operator reported the matter. They did not even tell the foreman about it. The Engineers' Department Office knew about it the next day for the first time. At noon the shoe was presented to us with the "compliments" of the safety department. Those two fellows lost a day and a half apiece because they did not report it. It happened that this particular crane operator had only been told two or three days previous by the Safety Committeeman about a nut that had fallen off his crane. He understands now. It meant about $7.00 out of his week's wages.

The safety idea has magnified itself so much that I cannot help but take this opportunity to tell you how successfully it works to bring about a condition whereby one workman judges his buddy. You would be surprised how much a workman hates to be judged by his buddy, and to what ends he will go to avoid criticism from the other workmen on account of his negligence. He feels it a great deal more than if the president of the company bawled him out. There is no question about that.

This collector shoe did not hit anybody, but the man who represented the safety department, and the man who represented the repairman spent just as much time arguing and criticizing as if it had killed

*Plant Engineer, The Midvale Co., Nicetown, Philadelphia.

half a dozen. Therefore accidents are becoming less frequent. It is soaking in.

We had gotten our record up to 99 days without lost time accident, and had the paper printed for 100, but the afternoon of the 99th day some fellow was rolling a tire, man tripped, and the tire fell on him. That knocked the 100 out.

It might interest you to hear something as to the organization. The Works Safety Committee is like most safety committees appointed by the management, and generally consists of five or six men, heads of departments, foremen, etc. I happened to be appointed on the first. I soon found out that men like myself, in more or less executive positions, were not going to make the progress we should unless we could sell the idea to the men. I thought we had better make our department sub-committee take more responsibility, and whenever they called a meeting I generally sat in. Mr. McTamney is a member of the main Works committee, and each department is supposed to have a sub-committee. Some of these men thought they were figureheads. We managed, however, to make them assume the responsibility which should be taken, and they have functioned actively for about eight months. This committee was appointed by myself, and each member represents certain groups of men. For instance, one would take all the crane repairmen. Another would take everything in the pipe fitters and ironworkers. An apprentice would take all the apprentices. That worked along for some time, and I wanted to test them out and see if they knew the men they represented, and the men themselves knew who represented them. I might ask a man, "Who is your safety representative? Do you know him?" Some did not know at all; they did not know anything about the matter. I also might say to the sub-committeeman on crane repairs, "Your night repairman tells me he does not know who his representative is on the safety committee." Committeeman replied, "You did not tell me to include the night turn." I reminded him that I said **every** crane repairman. We make every one work on safety. And do you know, at noon time, during the lunch hour, as well as in between, there are the darndest arguments about safety, and men will try to pick out impossible conditions that should be remedied, and some are very difficult, but have been corrected, even though considered for the past twenty years impossible to correct. The chairman of this sub-committee is a regular go-getter. He is so thoroughly sold on safety, I presume it is from some experience in a hospital during a severe illness, when he saw men brought in hurt through accident, and he never forgot the picture. Maybe the chap a couple of beds away was fatally injured. One of his talks runs something like this: "You fellows think this is all bunk. You think the Management thinks it all bunk. You think the Management is not going to do anything. You are all wrong. It makes no difference whether it costs a cent or a million dollars. If you fellows don't get busy and try to save somebody you are not going to get anywhere, or get a job anywhere else, because the question you will have to answer is: Are you a safe man? Do you feel well enough towards safety to enforce it? " One of his expressions is: "I don't care how strong a ladder, scaffold or a boatswain's chair looks, it's just as safe as the fellow that uses it. And don't come back and tell me that the company gave you a rotten ladder to use. As long as I stand here on two feet and talk, I am going to work for safety." He gives the men this kind of talk, and is so forceful he certainly is getting ahead. He is the fellow that was so disgusted with this crane operator two or three days ago.

I would like to ask what other concerns are doing in this respect, and who is held responsible for loose material overhead likely to fall; whether it is the crane operator, engineer or repairman.

Mr. Kennedy brought up the question of waste heat boilers. I know of no more uncertain problem than the horsepower or speed of a fan motor on a waste heat boiler. We have had several very amusing experiences with this problem. The figures showed we should use a 50-horse motor, but it had to operate eventually at 75.

John McTamney: I have no paper, but I want to show a little device that might prove interesting to some of our members. We have in service a 3-phase, 2250 KVA, 13200 volt primary transformer, water cooled, which supplies current to a 6-ton electric arc furnace.

This device, which is sketched on the board, is to prevent the transformer from being put into service without first having a sufficient amount of cooling water circulating, and if after it has been put into service, circulation of cooling water stops, or decreases below required amount, that transformer is automatically put out of service, and cannot again be put into service until the proper amount of water is circulating. As on most electric furnaces, the transformers are put into service at all hours, and without an electrical attendant, which makes the care of electrical equipment a second consideration.

A device such as this is very valuable to the electrical man. It is very simple to make up, and unless it is in working condition the transformer or unit which is being protected cannot be put into service.

When the proper amount of water is circulating through the transformer the small copper cup as shown becomes filled with water, closing the circuit, which operates main transformer switch, allowing the switch to be closed.

If the water stops circulating or there is not sufficient water circulating, the trip circuit of main transformer switch is closed, putting the transformer out of service. We tried to purchase such a protection as this, but could not find one on the market.

Geo. J. Walz: Mr. Gale has asked, who is the proper party to hold responsible for tools and other things left lying around on cranes. Our practice, which I think is very fair, is to hold the party responsible, to whom the tool belongs. If we find a ten-pound sledge, we know that it was left there by one of our machinists. If we find a magneto or some other purely electrical tool, we know that the mill electrician left it there. If it's a grease bucket or oil can, we know that the oiler has been negligent, and so on.

Mr. Gale has also referred to the man who inspects and repairs the cranes. We tried this combination system for a good many years, but could not make it work properly. The trouble we ran into was, that if the same man, who does the inspecting

also has to do the repairing, he is not going to be nearly as conscientious with his inspection. So, we finally picked out a man to do the Crane Inspecting, who does no repair work whatever. He is a mighty good man, and necessarily must be a particularly careful man, for circulating around on cranes while are in operation is the most dangerous job around a Steel Plant.

This inspector writes up a report covering all the faults relating to the condition of the crane, which require attention, and turns this report directly in to the Electrical Superintendent who turns the sheet over to the proper repair foreman. We found that with the old system, the repairs were not followed up nearly as well, for, if the inspector had to do the work himself, he was not so quick about seeing all the faults. If he reported them to a Repair Foreman, there was also a possibility there of the work dragging.

The Crane Inspector's job requires an exceptional man—he must not only be a first class combination electrical and mechanical repairman, but he must possess that rarest gift of all, of being able to look over a big piece of machinery, like a modern crane, while it is in action and pick out, almost at a glance, every detail that might require repairs, adjustment or betterment.

Mr. McTamney has expressed the thought that all welding work should come under the Electrical Department. At our Plant, this is not feasible, as the distance between some Departments is very long, so that it has worked out best to have each Department do its own welding in its own shop.

R. F. Gale: What he had reference to was the higher grade welding.

G. J. Walz: The Welders belonging to the other Departments are about as good as our men, though we do handle a somewhat larger variety of work, and more of it, as the Electrical Department has five electric welding machines, and six other Departments each have one or two electric welding machines.

Supplementing the scheme, which Mr. Dawson has mentioned for using gas on Commutator work, in their Repair-Shop—we have found a very convenient way of also applying it to similar work in the field. We take a small motorcycle size Prestolite Gas Tank which holds ten cubic feet of gas, and which one man can readily carry anywhere, and use it in combination with a small gas torch, for soldering, sweating and small brazing jobs. The old-style gasoline torch and soldering-pot are not to be compared with this combination for convenience and effectiveness.

F. O. Schnure: We have recently adopted that, too. I might say in regard to welding that at Sparrows Point we do the same thing. We have a couple dozen welding machines and hire a welder foreman to take care of the welding work. About six months ago we purchased our first automatic welding machine, and now have three working. To illustrate how advantageous they are, I might state we have a good bit of gas engine piston work. Normally in welding the grooves in gas engine pistons, one man with one automatic machine will do the work in one-third the time required for hand welding. At the present time we have one man looking after two welding heads. In other words he is doing the work of between four and six men, and doing a better job, and of course doing it much cheaper. You can get these welders from West Elect. & Mfg. Co., or General Elect. Co. They cost about $1,000 apiece. Ours are General Elect. Co.'s.

R. F. Gale: If you give these electric welding outfits out to the producing departments, and they have a particularly difficult problem, is the electrical department consulted?

Are they called in to see if they can correct the situation?

F. O. Schnure: In our particular case the mill welder is a very ordinary welder. Whenever we have a particular job or breakdown job, we always call our regular welding foreman over to take care of it. Then we also have to take care of the machines.

R. M. Fuller: As probably most of you know, for some time I have been devoting my attention to sales work, designing industrial layouts, and so I do not have very much to do in the shop, and do not run across the same experiences in the shop as you men do. However, I did run across something the other day that might be of interest to some of you. This is the first item on Mr. Schnure's list: Fuses versus circuit breakers. I was in a plant in which there was a small 5 h.p. motor driving an air compressor. They had had this work done automatic through a magnetic switch, and for some reason or other this particular motor was subject to high peaks of currents. At periodic intervals one of the fuses would weaken and go, and the first thing the motor would be burned out. They finally burned two motors out. Instead of resorting to the expedient of using overloading device to trip out, they rigged up an apparatus whereby if one of the fuses went it rang a bell. I don't recommend this particular type of motor overload protection, but thought perhaps some of you might be interested in it.

N. C. Bye*: I have only one question I would like to ask. Is it the policy in looking after the protection of electrical equipment to carry breakdown insurance on large electrical apparatus—transformers, generators and motors, or do most of the plants take care of that themselves? We carry this insurance and I would like to know if it is the policy of the other companies to carry the same kind of protection on their equipment.

F. O. Schnure: I think you will find most steel plants do not carry breakdown insurance. That insurance is invested in spare parts.

R. F. Gale: That insurance does not cover anything but the repairs on the machine; it does not cover lost time.

F. O. Schnure: Take a blooming mill motor. A blooming mill is worth $1,000.00 an hour every hour it is down. It is up to the Electrical Deptartment to see that enough spare parts are on hand to get any motor back in running order in minimum time. We usually carry one-quarter to one-third of a set of armature coils, field coils, bearings, on large motors, and in eight years' operation that is all that has been necessary.

N. C. Bye: One particular reason for my taking out insurance on one piece of apparatus was because it has gone up two or three times, and I thought it

*Henry Disston & Sons, Philadelphia, Pa.

would be good policy to be insured against a reptition of that same ccurrence.

F. O. Schure: I would like to ask a question: Does your insurance just cover the repairs on that machine?

N. C. Bye: Just the repairs.

F. O. Schnure: May I ask how much that covers? Suppose the motor costs $5,000, how much insurance?

N. C. Bye: The full value of the equipment.

F. O. Schnure: What is your premium?

N. C. Bye: I could not tell you off-hand. It only covers electrical breakdowns.

R. F. Gale: That question has been up several times with us. It was settled this way. Every piece of apparatus that failed generally resulted in a fire, and insurance policies against fire cover electrical equipment wherever located, therefore generally we collect. To date the failures that have not resulted in a fire have been in the minority.

A Member: I am of the impression that most of the insurance companies will indemnify you against loss of production.

F. O. Schnure: I imagine your premium would be pretty high in that case.

A Member: It seems to me where the motor is of real importance the cost of repairs is the least part of the loss: it is in the consequential damages, loss in production, where you lose your money.

F. O. Schnure: In regard to the company I am connected with, they carry their own insurance, maintaining a fire inspector whose duties are to fight fires and prevent them.

R. F. Gale: Again referring to loose material overhead. We tried the method first spoken of, i. e., holding the owner of the piece responsible, but we found this did not stop accidents, as we did not know that the hazard existed until too late. The reason we adopted the other scheme was to prevent the thing from being there, and if it was there to have somebody responsible for its removal before falling. The inspector or repairman may not go on the crane until the next day. He has been there and gone, and it is at these times things generally happen. We tried dividing the responsibility, but found, in spite of every effort, we must have one, and only one man responsible, and he cannot pass the buck along. It may be unreasonable at times, but these times are not as often as you would imagine.

A Member: Mr. Gale stated the number of days without accidents. This was very interesting. What is the number of men at your plant?

R. F. Gale: The number of men is 1700. We had gone ninety-nine days without lost time through accident. If a man is injured today, and goes home before the end of his shift, and does not return tomorrow, that is a lost time accident.

F. O. Schnure: I would think that was a very excellent record. We are working with it right now, trying to start up some safety enthusiasm.

R. F. Gale: I think the Illinois Steel has the best record of any in the country.

F. O. Schnure: On a working force of about 4500, I believe?

R. F. Gale: I don't know exactly; it is much larger than ours.

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*General Requirements for Safety**

(Continued from August, 1927, issue)

DROPS AND SKULL CRACKERS

1. All Drops, Drop Testing Machines and Skull Crackers should be enclosed with material of sufficient strength to stop flying pieces. "Danger—Keep Out" signs should be at all openings

2. The openings between the hoist house and the drop should be guarded by bars and screens, to protect the engineers. The rope used to release the ball should lead outside the drop.

ELEVATORS

1. Legal Requirements, such as local building codes, city ordinances, etc., should be observed, and if there is any direct conflict between these specifications and such legislation, the latter should, of course, take precedence.

2. Material and Workmanship must be first-class in every respect.

3. Factors of Safety: Elevator Equipment should be designed with the following factors of safety, based on the ultimate strength of the material used, when under full-load stresses.

4. Parts subject to dynamic strains, such as gears, gear shafts, drum shafts, etc., not less than ten (10).

5. Lifting and counterweight cables, not less than eight (8).

6. Other parts, such as cage framing, etc., subject to static strains, not less than five (5).

7. Elevator Equipment should be of metal or other approved non-combustible material throughout, with the exception of cage floor, which may be of hard wood not less than 3 inches in thickness.

8. Cables: There should be at least two lifting and two counterweight cables each. They should be of approved steel hoisting rope, 6 strands, 19 wires to the strand. Sheave diameter to be not less than forty times the diameter of rope. Hand line to be of tiller rope, "6x6x7" construction; sheave diameters for tiller rope must be at least twenty-seven times that of the rope.

9. Both lifting and counterweight cables of a drum machine elevator should have at least two full turns of cable on the drum when the car is at the lowest and highest points of travel.

10. Sheaves of operating rope must be thoroughly guarded, so that the rope can not be misplaced.

11. Cage: Unused sides of cage must be enclosed to a height of 6 feet from the floor. This enclosure may be of woven steel fabric, No. 9 wire, 1-inch mesh, where it is desirable for the operator to see

*Prepared by the Committee of Safety, United States Steel Corp.

through the enclosure, otherwise sheet steel (not less than No. 14 gauge) should be provided.

12. Elevator cage should be provided with substantial cover, to prevent danger of tools or material falling on persons in the cage. The front part of this cover may be hinged, thereby providing for the carrying of long material.

13. Speed Governor: All elevators upon which men ride should be equipped with an approved speed governor.

14. Safety Clamp: All elevators upon which men ride, except those of hydraulic plunger type, should have an approved type of safety clamp, which will engage the guides and stop the car in case the hoisting cables should break or become detached. This clamp must be thrown into engagement by a spring or mechanical device, and not by gravity; it must be arranged, however, so that the gripping power of the clamp is not obtained from a spring.

15. Hydraulic Elevators should have suitable provision to prevent plunger being forced out of cylinder in case of accident to controlling mechanism.

16. Gates must be placed at all entrances, and they should be preferably of the automatic type.

17. Gates should be 6 feet in height, wherever possible; if this height is impracticable, gate should be placed not less than 12 inches from the platform of the cage and telltale chains should be suspended from the edge of the bottom of cage.

18. Floor-beam Guard: Where the elevator cage passes close by beams, floors, etc., they should be beveled off and sheeted over, to prevent possibility of a foot being crushed between them and the floor of the cage. This beveled guard should be sat at an angle of not less than 60 degrees with floor level.

19. Platforms, with standard railing and toeboards, should be placed at top sheave, for use of oilers, repairmen, etc. These platforms should be equipped with permanent stairs or ladders.

20. A Pit at least 3 feet 6 inches in depth must be provided at lower floor, and an equal clearance allowed between overhead platform or beams and top of cage when it is at upper floor level.

21. Bumpers should be placed at bottom of elevator pit. They should be of such length as will insure a minimum clearance of at least 2 feet 6 inches between bottom of cage and pit floor, to prevent danger of any one being crushed by the descending cage.

22. Additional counterweight bumpers should be provided, on which the counterweights will come to rest when the car is 2 feet 6 inches below overhead beams or platform at top of shaft.

23. Safety Lock: All elevators should have a safety switch or valve equipped with a locking device, on each floor and at the hoisting mechanism, which when used will set a brake, making it impossible to move the elevator.

24. Gong: Suitable electric or mechanical signaling gong should be provided for each elevator, so arranged that it can be rung from any floor served.

25. Counterweights: All counterweights should have their sections securely bolted together, and they should be so situated that they can not fall on any part of the elevator or machinery. There should be not less than 2 feet 6 inches clearance between top of counterweight and under side of overhead beams when the car is resting on the bottom bumpers.

26. Counterweight slides should be guarded where there is danger of some one having a hand caught between the weight and framing. A door or other suitable provision should be made, to allow for convenient inspection of counterweight cables.

27. Stop Buttons: Two stop buttons should be placed on operating rope at both top and bottom positions, separated about ¼ inch, so that if one slipped the other would stop the car. These should be located so that they only come into play after the car has gone a few inches beyond its normal stopping position, so that the operator will not depend upon them for his ordinary stops. They are for emergency service only. The stop-motion device on engine or motor-driven elevators should be arranged to operate at terminal floor levels.

28. Signs: Standard sign reading, "Danger; Do Not Ride On Elevator; Use Stairway," should be posted in a conspicuous location at each freight elevator.

29. A standard sign reading, "Capacity of This Elevator Is ..... Pounds; Do not Overload It," should be permanently displayed in each elevator cage.

30. Motors: Where elevators are driven by electricity, the controller board, motor and starting mechanism, etc., should be placed in such location that they are not liable to be obstructed by stock or tampered with. Where they are in a common room of warehouses, storehouses, etc., they should be partitioned off or enclosed with woven steel fabric, No. 9 wire, 1-inch mesh, or other suitable non-combustible material. A door with lock should be provided for entrance to this enclosure.

EMBANKMENTS AND EXCAVATIONS

1. All embankments, runways, platforms, etc., over five feet high, and those of less height which are dangerous, should be railed.

2. All excavations that are liable to cave in should be shored up. These excavations should be protected by barriers, and at night by lights.

ENGINES

1. Gas-engine Basements: Toilets, Rooms or Places where men may congregate should not be allowed in any gas-engine basements.

2. In the installation of new engines, as little of the machinery and appliances as possible should be placed in the engine-room basements.

3. Steam Engines: The Governor, if not of the shaft or fly-wheel type, should be driven with ropes not less than three in number.

4. The Governor Sheaves should have suitable guards of substantial construction; sheaves to be keyed to shaft, and unused portions of keyway filled so as to present a smooth surface.

5. Where Fly-ball Governor is used, the revolving parts should be properly guarded.

6. Keys should be used instead of set screws in all moving parts wherever possible.

7. Main Bearings which can not be readily reached from the floor should be equipped with steps of approved safety treads and properly railed.

8. Platforms, Walks and Stairways on engine should have railings and toe-guards of standard design. This applies also to the engine bed where it is subjected to use as a foot-walk alongside of the connecting rod or cross-head.

9. Stationary Stairs or Iron Ladders should be provided for access to emergency valves which cannot be reached from the floor or other safe places.

10. Connecting Rods, Cranks and Tail Rods should be protected by approved guards, unless oil shields are so arranged as to thoroughly enclose and safeguard these points.

11. Fly-wheels should be guarded by either plate or suitable wire fencing. Where the protection is within 15 inches of the wheel, it should be at least 5 feet high; where it is more than 15 inches from the wheel, it should be at least 3 feet 6 inches high, and at the ends the distances should be measured from the periphery of the wheel. The guards should be carried over the bearings at the same relative height. The outside guard on the stairs over the bearings may be made of bare railings.

12. Wheels less than 5 feet above the floor line where the protection is less than 15 inches from the wheel should be entirely encased.

13. A Relief Valve should be placed in each end of each cylinder, and these valves should have means for testing to make sure that they are always in working order.

14. Care should be taken in regard to the design of valve mechanism and other moving parts to avoid places where a hand or foot might be caught and crushed. Where such places necessarily occur, they should be properly guarded.

15. Live-steam Connections should not be made to a receiver without a reducing valve set so that the pressure it will permit shall be well within the safe working pressure of the receiver and the low-pressure cylinder.

16. Receivers should be equipped with one or more safety relief valves of ample capacity and set to blow at a pressure well within the safe working pressure of the receiver and low-pressure cylinder. These valves should have means of testing, to make sure that they are always in working order.

Condensing engines should be provided with means for breaking vacuum at the same time that the automatic engine stop shuts off the steam. Where other engines are on the same condenser, a quick-closing valve on the exhaust should be provided, and in such cases vacuum-breakers would not be required.

17. Jet-condensers should be provided with a float-operated vacuum-breaker to open when the water rises to a predetermined level in the condenser, in order to prevent water getting into the engine cylinders.

18. Steam Traps used to discharge the water from steam separators should be so placed that it will be known that they are operating. If it is necessary to locate these traps below the engine-room floor or any place where their operation cannot be seen, an electric light or some other signal device, such as a bell, should be used to indicate when the trap discharges.

Accidents are liable to occur if traps are not kept in good working order.

It is advised that each company have a blank printed, which may be called "Engine Inspection Report," or otherwise designated. The purpose of this blank is to afford a convenient and easy method of keeping a record of inspection of engines and to provide a permanent record of the condition of each part of an engine which will always be available for reference in case of accident. The form of report and the time of inspection of each engine should be arranged by the management.

19. General: All openings or key-holes in rams on pressure pumps, engine, etc., should be plugged to avoid possibility of men getting fingers in hole while machinery is in operation.

20. Exhaust Pipes within seven feet of the ground, or in such a position as to endanger a passer-by, should lead into exhaust pits, which pits should be covered with metal covers and provided with adequate drains.

21. Automatic Relief Valves should be provided on the free exhaust line.

22. Relief of Condensation in receiver and exhaust pipes should be provided for.

23. Engines should be equipped with quick closing valves and automatic speed limit devices and means provided for shutting down engines from various safe points.

No auxiliary or by-pass valve should be installed in conjunction with the quick closing valve.

A system of regular inspection and testing of these automatic stops and speed limits should be devised at each Works to suit local conditions. Where engines are shut down frequently, as at the end of each turn, a good means of testing the automatic stop is to use it in shutting down the engine. If electrically actuated automatic stops are used, the wiring system should be on a closed circuit. Wires should be placed in conduits if possible and should be looped so that each circuit can be tested separately and so that in case of a break in one line no other line will be put out of service. If current for operating the solenoid stop mechanism is always available, an auxiliary battery is not necessary, except to insure continuous operation of the engines. The storage type of battery is the most reliable.

GAS PIPES AND PRODUCERS

1. Provision should be made so that when a producer is shut off from the main pipe, or when a soaking pit or a furnace is cut out, the gas cannot accidentally be turned on again.

2. Cleaning Doors on gas pipes opening on a platform or walk should be so constructed that they can be locked shut to prevent a back-pressure of gas forcing them open.

3. Explosion Doors should not be so located that they will open on a floor or walk used as a passageway.

4. Cleaning Doors or Explosion Doors on gas pipes or mains should be hinged. Where there are counterweights on explosion doors, they should be provided with safety chains or other devices, to prevent the weight or door falling should something break.

5. Bar-hole Stoppers should be put on with hinges.

GUARD RAILS AT BUILDINGS

A guard rail should be placed at the doorways or corners of buildings near railroad tracks, to prevent a person suddenly stepping on the track.

PLATFORMS AND WALKWAYS

1. General

(a) Platforms and Walkways should be provided whenever regular duties require an employee to ascend to, or go into, places where injury could result from falls or contact with moving parts or other objects.

(b) Platforms and Walkways should be reached by stairways or stationary ladders, preferably stairways.

2. Floors

(a) Floors should be designed with a minimum strength of 50 pounds per square foot.

(b) Floors should have anti-slip surfaces.

(c) If rolled steel plate is used, it should be of the checkered, indented, or other anti-slip type, not less than ¼ inch thick.

(d) If steel fabric is used, it should be not less than No. 9 wire, and not larger than ¾ inch mesh.

(e) If concrete is used it should be steel reinforced.

(f) If of the grated type, the openings should be not larger than ¾ inch (grating with parallel bars should be avoided).

(g) Wood should not be used for permanent installations, but if necessary to use wood for temporary structures, it should be unsurfaced planking at least 2 inches thick, with openings between planks not larger than ¾ inch.

3. Width

Minimum width of platforms and runways should be 27 inches.

RAILINGS AND TOE BOARDS

1. General

(a) Railings and toe boards should be provided on unprotected sides and ends of all platforms, inclines and walkways 5 feet or more above the ground or floor.

(b) Railings should preferably be of structural steel shapes, though in the better class of buildings, such as power houses and machine shops, pipe railings may be used where not exposed to moisture or gases. Wood railings should not be used except to afford temporary protection.

(c) Railings should have a smooth finish, rough edges and sharp corners should be removed, angle posts should be chamfered.

Where railings pass floors, platforms or other structures, ample clearance should be allowed for hand between rail and structure.

2. Railings and Toe-Boards for Platforms and Walk-Ways

(a) Railings should be 42 inches in height and provided with an intermediate rail between the top rail and the floor.

(b) Dimensions of various types of railings should be not less than the following:

(1) Structural Steel Shapes.

Top rail	3″x2½″x5/16″ angle.
Intermediate rail	2½″x2″x5/16″ angle.
Posts	2½″x2½″x⅜″ angle.
Toe-board 6″ high	6″x3″x5/16″ angle.
Spacing of posts.	Not more than 8 feet apart.

(2) Pipe Construction.

Type	Special fittings for railings. Preferably all members should be properly fitted and pinned, avoiding the use of threaded connections.
Size	All members 1½″ inside diameter.
Toe-board	6″ high-6″x⅜″ flat.
Spacing of posts.	Not more than 8 feet apart.

(3) Wood Construction.

Top rail	2″x4″ (dressed)
Intermediate rail.	1″x4″ "
Posts	2″x4″ "
Toe-board	1″x6″
Spacing of posts.	Not more than 8 feet apart.

3. Railings and Toe-Boards for Stairways

(a) Railings and toe-boards for stairways should be the same size as railings and toe-boards for platforms and walkways, except the height of toe-boards for intermediate landings, which may be 5 inches. For general construction, see Figures 1 and 2 under Stairways.

(b) Stairway handrailings should have a smooth finish. Rough edges and sharp corners should be removed in the shop. Any remaining after erection should be chipped or filed.

(c) Railings should be provided on each flight of stairs as follows:

(1) On all open sides.

(2) On one side of enclosed stairways 4 feet or less in width, preferably on both sides.

(3) On both sides of enclosed stairways over 4 feet in width.

(4) On both sides and in center of stairways over 8 feet in width.

(d) All intermediate landings should be provided with a toe-board, or other enclosure in addition to hand rail.

STAIRWAYS

1. General

(a) Stairways should be used wherever practical, in place of ladders. The following general rules should govern their design:

(1) There should be uniformity of angle for all stairways in so far as practical.

(2) They should preferably be designed between the angles of 20 degrees and 50 degrees.

(3) For a grade less than 20 degrees an incline, or ramp, is preferable.

(4) An angle of 50 degrees to the horizontal is considered maximum for safety for stairways. Stairways of a slope this

steep should be used only for short flights. Where a continuous flight requires an angle as great as 50 degrees, it should be overcome by breaking the flight and reversing the direction.

(5) Long flights should be avoided by the provision of intermediate landings.

(6) Spiral stairways should not be substituted for regular stairways where practical to install the latter. However, they are considered preferable to ladders.

(7) Where stairways with open risers pass over alleys, walkways, door openings to buildings, etc., a protecting plate should be placed on the under side of the stair stringers.

2. Dimensions of Stairs

(a) Minimum width of stairways should be 27 inches.

STANDARD DETAILS FOR STAIRWAYS & STRUCTURAL HAND RAILS

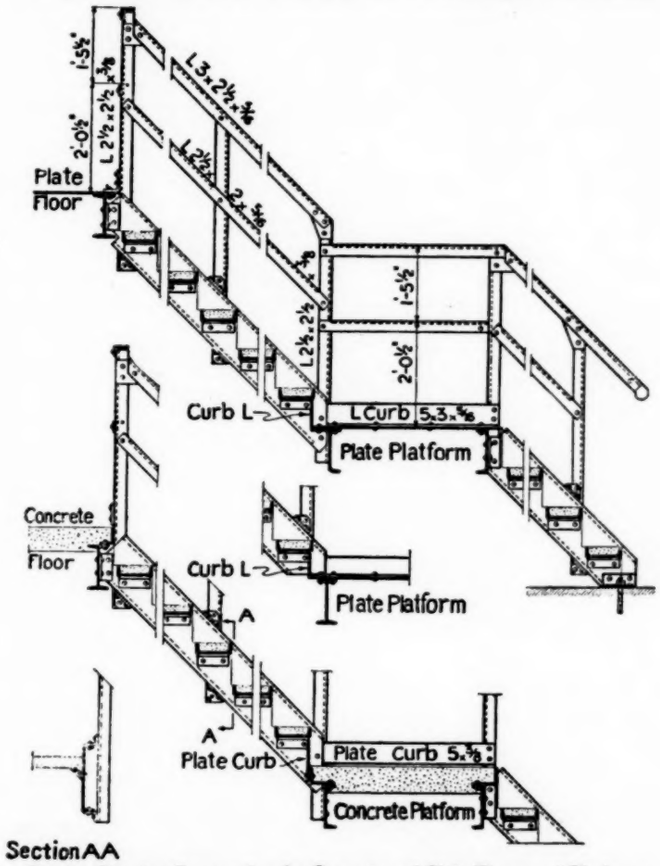

Fig. 1. Showing Construction for Concrete and Plate Floors and Platforms

(b) The width of intermediate landings should be proportioned to a multiple of the natural pace (approximately 25 inches).

3. Risers and Treads

(a) All risers and treads in the same flight of stairs should have uniform dimensions.

(b) No tread should be under-cut more than one-third its width.

(c) When the nosing of the tread is rounded, the radius should not exceed three-eighths inch.

(d) Treads should have anti-slip surfaces. (The inverted channel filled with cement and surfaced with carborundum chips is recommended).

4. Doors and Gates

No door or gate should extend over the top riser when open full width, nor should it be nearer the top riser than the width of three treads.

STANDARD DETAILS FOR STAIRWAYS & GAS PIPE HAND RAILS

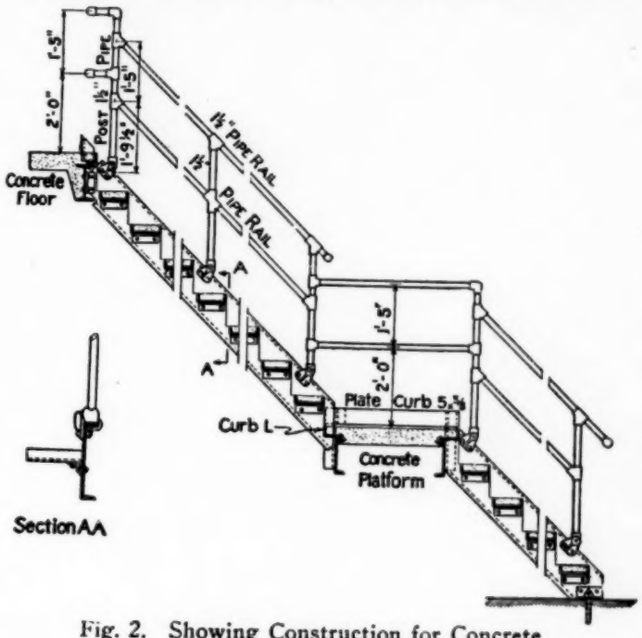

Fig. 2. Showing Construction for Concrete Floor and Platform

Note:—Complete working drawings of the stairs and hand rails shown in Figures 1 and 2 may be obtained by application to the American Bridge Company.

TABLE—Dimensions for Stair Treads and Risers

A		B		C		D	
Slope 9 5/16" in 1'=38° 40'		Slope 10 7/16" in 1'=40° 58'		Slope 11 7/16" in 1'=43° 22'		Slope 12" in 1'=45°	
Riser	Tread	Riser	Tread	Riser	Tread	Riser	Tread
8⅛	10⅛	8⅜	9⅝	8¼	9¼	8¼	8¼
8	10	8¼	9½	8⅜	9⅛	8⅜	8⅜
7⅞	9⅞	8⅛	9⅜	8½	9	8½	8½
7¾	9⅝	8	9⅛	8⅜	8⅞	8⅜	8⅜
7⅜	9½	7⅞	9⅛	8¼	8¼	8¼	8¼

5. Ramps

(a) Anti-slip surfaces should be provided for ramps. They should not be of greater incline than 1 foot rise in a 3 foot run.

(b) When the incline exceeds a 1 foot rise in a 6 foot run it should be provided with cleats spaced not more than 8 inches apart.

6. Railings

Railings should be in accordance with Standard Design. (See Railings and Toe Boards and Figures 1 and 2 showing standard details for Stairways and Hand Rails).

(a) Stairways should preferably be restricted to the four slopes shown in the above table except when flatter slopes are desirable. This is sometimes the case for office buildings and for entrance stairs that are used by a large number of people. While an angle of 50 degrees to the horizontal is considered maximum for safety, it is desirable that stairways should not be built at a greater inclination than 45 degrees.

(b) In designing a stairway the slope which best fits the condition should be used. The preferable risers and treads are underscored. It is seldom necessary that the horizontal run of stairs should conform to an exact figure. A slight variation will do no harm, thus allowing a standard tread to be used. All risers for a flight of stairs should be the same height and this height should be maintained wherever possible in adjacent stairways. No stairways should be more than 24 risers in height. Intermediate landings should be introduced where height is excessive.

(c) For slopes A, B and C, standard pipe connections have been determined. (See Railings and Toe Boards "General" as to use of pipe railings).

STATIONARY LADDERS

The term "Stationary Ladder" means a ladder that is substantially fastened to a structure in a fixed position.

1. General

(a) Ladders should be avoided where the use of well constructed stairways is practical.

(b) Steel construction should be used. Wood construction should not be used except as a temporary installation or in places where steel may be disintegrated by gases or fumes.

(c) The pitch of a ladder should not be such that the position of a person is necessarily below the ladder when climbing.

(d) Back clearance.—Back of rung to nearest permanent object back of ladder not less than 8".

Front clearance.—No obstruction less than 30", except where safety cages are applied.

Side clearance.—15" from center on either side of ladder.

(e) Outside ladders should extend at least 45" above landing, preferably being goose-necked, or bridged. Rungs should be omitted above landing. A platform should be provided where a person must step a greater distance than 18" from ladder to roof, tank, etc.

(f) High ladders, with the possible exception of fire ladders, should be divided into short lengths, placing landings every 20 feet.

(g) Safety cages should be placed on ladders that are 20 feet or more in height. This applies to ladders used in regular mill operation. Where ladders are used infrequently, the question of installing safety cages should be determined in each instance. (See safety cages for ladders).

2. Steel Construction

(a) Size of rails.—Not less than ¾ square inch cross section. (2"x⅜" recommended).

(b) Space of rails.—16" to 24" apart, using as a standard the width most common, if between these limits.

(c) Splice plates.—Same size as material for side rails; should be on outside of side rails and double riveted or bolted. The rivets or bolts should be countersunk on inside and should be not less than ½" nor more than ⅝" in diameter, where cross-section does not exceed that of 2"x⅜". Length of splice plates should be 4 times the width.

(d) Rungs.—Not less than ¾" in diameter and fastened so as to prevent turning.

(e) Spacing of rungs.—12" center to center.

(f) Fastenings.—Metal equivalent to rails in strength. Fastenings should be made to permanent structure by rivets, by building in, or by through bolts or expansion bolts, grouted or leaded. Fastenings should not be more than 10 feet apart.

3. Wood Construction

(a) Material.

Side rails.—Northern spruce, or wood equivalent in strength dressed on all sides. Should be straight-grained and free from knots (knots ½" or less in diameter will be permitted when in center of rails).

Rungs.—White ash, oak (3rd growth) or hickory. Should be straight-grained, absolutely free from knots and should be split from stock before being turned.

(b) Size of rails.—Not less than 6 square inches in cross section with a minimum thickness of not less than 1½ inches.

(c) Space of rails.—16" to 24" apart, using as a standard the width most common if between these limits.

(d) Splice plates.—Metal, equivalent in strength to rails. Should be on outside of side rails and double riveted or bolted. The rivets or bolts should be countersunk on the inside. Length of splice plates should be 4 times the width of side rails.

(e) Rungs.—Not less than 1½" in diameter with tenon at least 1" in diameter or its equivalent in strength. Rungs should be fastened to prevent turning.

(f) Spacing of Rungs.—12" center to center.

(g) Fastenings.—Material equivalent to rails in strength. Fastenings should be made to permanent structure by rivets, by building in, or by through bolts or expansion bolts, grouted or leaded. Fastenings should not be more than 10 feet apart.

4. Safety Cages for Ladders

(a) Hoop bars
Size.....⅜"x2" steel
Spacing.....4' to 6' centers
Diameter.....27" (inside)

(b) Vertical bars
Size.....½"x2" steel
Numbers.....7 (equally spaced) riveted to Hoop Bars, rivets countersunk on inside.

(c) The cage should be carried at least 3′ 6″ above the top landing. The members of cage, with exception of entrances, should be continued clear to the ground, wherever practical, and fastened to the floor or foundation. Where ladders are located in passageways, or in places where this would encroach on the floor space, the bottom section of the cage may be omitted to a height of about 7 feet from the ground.

(d) Where a caged ladder is so located that it could be ascended on the uncaged side, a sheet steel baffle, at least 6 feet high, should be provided to prevent access to the uncaged side of the ladder.

PORTABLE LADDERS

The term "Portable Ladder" means a ladder which may be transported from one place to another and shall include both straight and extension ladders.

1. General

(a)The maximum length of portable straight ladders should be 20 feet; over this length an extension ladder should be used.

(b) Material.—Side rails.—Northern spruce, or wood equivalent in strength, dressed on all sides. Should be straight-grained and free from knots, checks or other defect.

Rungs.—White ash, oak (3rd growth) or hickory. Should be straight-grained, absolutely free from knots and should be split from stock before being turned.

(c) Rungs should be fastened so as to prevent turning.

(d) Portable ladders should be equipped with ladder shoes.

(e) Portable ladders purchased from ladder manufacturers should be specified "UNPAINTED" and the painting done at plant after inspection.

2. Portable Straight Ladders

(a) Portable straight ladders should conform to the following table of dimensions:

Length	Size of Side Rails		Inside Width of Side Rails		Tie Rods		Diam. of Rungs		Spacing of Rungs
	Width	Depth	Top	Bottom	No.	Size	Between Rails	Tenon	
10′ or under	1⅛″	2½″	15″	20″	2	⅜″	1 1/16″	⅞″	12″
Over 10′ up to 16′	1¼″	2½″	16″	22″	3	⅜″	1 1/16″	⅞″	12″
Over 16′ up to 20′	1⅜″	2¾″	16″	24″	3	⅜″	1 1/16″	⅞″	12″

3. Extension Ladders

(a) It is recommended that all extension ladders be made to have an overall length, when fully extended, of 30 feet, the bottom sections being 18 feet long, the top section 16 feet long and the two sections overlapping 4 feet.

(b) Extension ladders of this type should conform to the following table of dimensions:

Length	Size of Side Rails		Inside Width of Side Rails		Tie Rods		Diam. of Rungs		Spacing of Rungs
	Width	Depth	Top	Bottom	No.	Size	Between Rails	Tenon	
18′ (Btm Section)	1⅛″	3″	17″	28″	3	⅜″	1 1/16″	⅞″	12″
16′ (Top Section)	1⅛″	3″	14″	14″	3	⅜″	1 1/16″	⅞″	12″

(c) The taper of rails for the bottom section should start at about middle of section (9 feet from bottom).

(d) The top section should be so arranged that it cannot be readily detached from the bottom section.

HOOKS

1. Hooks should be designed amply strong, with a factor of safety which will render them safe under any load which may possibly be carried by the crane.

2. It is recommended that all hooks be equipped with safety handles.

LADLES

1. Ladle Trunnions should be drilled and tested before being placed in service.

2. Ladle Cars should have a steel underframe and should be equipped with some device for keeping ladles in an upright position.

3. Ladles must be bottom-heavy, so as to assume an upright position in case of breakage of any part of dumping mechanism.

4. Ladles should be equipped with automatic couplers and, where they are handled on grades, with safety chains.

5. All cars used for transporting hot metal or cinder in train movements over the highway of an Interstate carrier should be equipped with air-brakes, hand brakes and grab irons, including such cars used interchangeably in switching and train movements.

6. All hot metal and cinder ladle cars, whether used in switching movements or hauled in trains, wherever practicable, should be equipped with end hand holds to afford greater safety to employees when coupling and uncoupling cars.

7. All hot metal and cinder ladle cars, regardless of service involved, should have a notice painted thereon, "keep off."

8. Cinder Ladles (open-hearth slag pots) should be cast with lugs or loops that will afford secure hold for crane hooks.

LEVERS, SWITCHES AND HAND WHEELS

1. All levers, switches and hand wheels controlling the movements of machinery should be so constructed that they can be locked with a padlock, to prevent starting the machinery.

2. A Cotter Pin or Lock Nut should be placed on all operating levers and hand wheels to guard against the possibility of their coming off.

3. Bleeders should be provided in hydraulic or steam piping between the valve and the cylinder, to prevent a leak causing the movement of the machinery after the controlling mechanism is locked.

MANHOLES, PIT COVERS AND TRAP DOORS

Manholes, pit covers and trap doors should be so constructed that at least three sides of the hole will be guarded when cover is raised.

MILLS

1. Subways or Viaducts should be provided where passageway across the mill is required. Subways should be roofed to prevent scale from the table falling into them. Table shafting which can be reached from subway or stairs should be encased.

2. Drive Shafting on Roller Tables should be covered with hinged plate covers over the top of shafts, and with hinged aprons at the side, or entirely encased.

3. Coupling Boxes, Breaker Blocks, Pinions, Warblers and Spindles should be guarded with shields.

4. Leading Spindles should be fenced if not otherwise guarded.

5. Viaducts should be provided where passageway over spindles or mill tables is required.

6. Platforms should be placed on roll and shear housings 6 feet or higher above the floor, with stairs or ladders leading to same.

7. A Walk Running Parallel with Crane Runway should be placed on all building wherever practicable.

8. Safety Switches should be installed in turntable pits, so that men going into the pit can cut all power off from the table.

9. Bumpers should be placed at the dead end of all roller tables, to prevent material overriding the end of the table.

10. Bed Guards should be placed at the outside ends of the skids of all loading beds, to prevent material accidentally falling from the bed.

11. Scale Tunnels under mills should be arranged, where practicable, so that it will not be necessary for men to go under table when removing scale.

OPEN HEARTHS

1. Open-hearth Furnaces being rebuilt below the charging-floor level should be guarded by a tight plank fence across the entire front of the furnace, on the charging floor, to prevent material falling on men working in the furnace ports.

2. Provision should be made so that when a furnace is down for repairs the gas cannot accidentally be turned into the furnace.

3. Furnaces and Pits should be designed for removable receptacles into which slag, kish, etc., may flow or be dumped, and a sufficient number of these receptacles should be provided so that slag may become solid before dumping, unless disposed of in a molten state.

4. The uncapping stand should be equipped with sliding doors or railed off to such a distance as will allow the proper cooling of ingots before moulds can be uncapped.

5. Pouring platforms should be amply large and provided with a number of exits to allow men to escape in case of accident.

RAILROAD IN MILL YARDS

1. All Cars on narrow-gauge or standard-gauge tracks should be provided with either automatic M. C. B. standard or automatic link and pin couplings.

2. All Special Railroad Cars for skelp steel, open-hearth charging boxes, etc., should be provided with suitable side stakes or end stakes.

3. Portable Derailers should be installed on all loading and unloading tracks where men work on cars.

4. All Dead-end Tracks should be provided with approved bumping blocks.

5. All Dangerous Places, when practicable, should be provided with overhead bridges or subways, to keep men off the tracks entirely.

6. The design and application of all safety devices should be in accordance with the Federal and State Railway Safety Appliance Laws.

7. All Frogs, Switches and Guard Rails should be blocked.

8. When New Switch Stands are installed they should be constructed so that the ball will be thrown parallel with the rails.

SAWS

All circular and band-saws, jointers, planers, etc., should be provided with approved guards.

SCAFFOLDS

1. All lumber used in constructing scaffolds should be long leaf yellow pine, spruce, Douglas fir or Norway pine.

Note:—Scaffold lumber should be selected when lumber is received at the storeyard, tested by at least double the load it is to carry, marked by a distinguishing mark, and placed to one side for scaffold use only.

See pamphlet "Constructing Specifications and Operating Rules for Mill Scaffolds," issued by Committee of Safety.

SEWERS

Sewers for steam or hot water should not be covered with planking only; use metal, brick or cement.

SKYLIGHTS

Skylights should be constructed so as to eliminate all danger from falling glass.

SLINGS

1. Method of Attaching Cable to Hooks: It is recommended that wire cable be attached to hooks in one of the following ways:

(a) By passing the rope through the hook and back, using at least two clamps.

(b) By the use of a thimble with the rope spliced back into itself and well bound with a substantial cord, or

(c) By the use of a socket.

2. All slings used on hoists should, where practicable, be made of wire cable, instead of chain, as cable gives warning of weakening by broken strands.

STEAM LINES

Note:—See "Boilers" and "Engines."*

1. Permanent Small Steam Lines, when placed underground, should be boxed in so that leaks will not cut away the earth, making a pocket into which some one might step.

2. High-pressure Steam Lines should not be run through offices unless thoroughly protected against breakage.

TRAVERSING CARRIAGES OF MACHINES

The traversing carriage of any machine, engine or lathe should not be allowed to run out within a distance of 18 inches from any fixed structure not being a part of the machine if the space over which it runs is space over which any person is liable to

*August Issue Iron and Steel Engineer.

pass, whether in the course of his employment or otherwise.

TRESTLES

1. Trestles should be equipped with walks, the outer edge of which should be at least 6 feet from the rail. Where practicable, the floor of this walk should extend to within 4" of the ends of the ties. Each walk should be equipped with a substantial metal railing and toe-board.

2. Where there is a driveway or passageway under a trestle it should be completely planked over at that point, between the rails and between the tracks.

3. Bents or trestle supports should be enclosed, forming division walls, keeping iron from tangling around legs of open bents supporting trestle. (Do not advocate division walls except where trestle supports are located).

4. On trestles over pig-iron yards and other places where material is unloaded from side of cars, footwalk can be placed at a distance, and part of floor of walk can be arranged so that it can be lifted to allow metal or other material to fall through.

VALVES

1. Platforms, stairs or stationary steel ladders should be provided, by which to reach emergency valves higher than an ordinary man.

2. A cotter pin or lock-nut should be placed at the ends of all valve stems, to prevent the wheel slipping off the shaft, and important valves should be marked for identification.

3. Levers and chains operating gas and steam valves should be provided with a locking device.

WINDOWS

Safe means should be provided for cleaning windows or skylights. Properly equipped cages, running on track or runways, railed and with toe-boards, are suggested. These installations must safeguard the men against crane travel or other moving machinery.

YARD CLEARANCES

Where clearances have not been established by law, the following clearances are recommended:

A

Broad-gauge track minimum clearance to structure or material pile:

1. Side Clearances:

(a) 5 feet 8 inches from center line of track to loading or unloading dock, walls of depressed track and wheelbarrow platforms.

(b) 7 feet from center line of track in all stockyards.

(c) 8 feet 6 inches from center line of track wherever not otherwise specifically provided.

2. Overhead Clearance:

(a) 21 feet from top of rail to any structure.

(b) 25 feet from top of rail to any wire.

(c) 35 feet from top of rail to any high-tension transmission power line.

B

3. Narrow-guage Track Minimum Clearance to Structure or Material Pile:

(a) Side clearance at all places to be 4 feet from rail.

(b) Overhead clearance to be governed by local conditions.

(c) Where cars of unusual widths and types are used on narrow-gauge tracks, a minimum clearance of 18 inches should be allowed between the car and any structure, or between cars on parallel tracks.

C

4. Track Clearances:

(a) 13 feet from center line of one broad-gauge track to center line of adjoining broad-gauge track.

(b) 11 feet 6 inches from center line of one broad-gauge track to center line of adjoining narrow-gauge track.

(c) 10 feet from center line of one narrow-gauge track to center line of adjoining narrow-gauge track.

The above clearances, A, B and C, are based upon a tangent measurement. Where track is on a curve, allowance should be made for the curve in the track, so as to maintain for all uses of the track a clearance equivalent to required clearance for a straight track.

5. Standard-gauge tracks used only for narrow-gauge equipment are to be considered as narrow-gauge tracks.

6. "No Clearance" signs, placed not over 7 feet from the top of rail, should be maintained to indicate all places where the clearance for broad-gauge tracks is less than 8 feet 6 inches from center line of track.

TRANSMISSION MACHINERY

Shafting, Pulleys, Belts, Rope Drives, Clutches, Gears, etc.

Overhead Transmission

1. Any portion of an overhead shaft, pulley, belt, rope drive or other moving part which comes within seven (7) feet of the floor or platform level, or which must be approached while in motion, should be enclosed on the sides and bottom or guarded by a standard railing giving at least fifteen (15) inches horizontal clearance from the part guarded.

2. Ends of Shafting projecting more than one (1) inch from bearing or having an unfilled keyway in same should be cut off or guarded

3. When a gear or pulley wheel is located on the projecting end of a shaft, the shaft should extend at least the diameter of the shaft outside of the hub of the wheel, and provision should be made for locking the key so that key cannot loosen and wheel slip off.

4. Clutches and Shaft Couplings with exposed mechanism or projections should be enclosed.

5. Walks for the use of the oiler should be provided where overhead shafting is to be oiled while running. The railings of these walks may be so constructed as to fence the shafting. Walks should be so constructed that belts will not pass through nor across them. If this is impracticable, then the belts should be guarded.

6. Oil and Grease Cups should be placed on extensions when such an arrangement will safeguard the oiler or facilitate his work.

7. Pulleys on Line Shafting should be so placed as to allow not less than one inch in excess of the

width of the belt between the pulley and the shaft hanger or an adjacent pulley, or a guard should be placed to prevent belt slipping off pulley.

8. Belt Perches or Hangers should be provided for all belts not equipped with loose pulleys. Idle belts should not be allowed to ride on shafting.

9. A Belt Shifter should be provided for tight and loose pulleys, so designed that the belt may be locked on either pulley.

10. Heavy Belts seven (7) feet or more from the floor and so located that they would endanger people below in case of breakage should be guarded underneath.

Low Transmission and Machine Protection

11. Belts, pulleys, shafting, fly-wheels or other dangerous moving parts which are less than seven (7) feet above the floor or platform level should be guarded in accordance with the following:

(a) When the guard is placed not less than fifteen (15) inches and not more than twenty (20) inches from the moving part, a standard railing forty-two (42) inches high constructed of metal may be used.

(b) If the guard is placed less than fifteen (15) inches and not less than six (6) inches from any moving part, it should extend from a point two (2) inches below the lowest moving part to six (6) feet above the floor or platform level, and should be constructed of wire mesh of not less than 12-gauge wire and not more than 1½-inch mesh, or steel casings (preferably perforated to allow for inspection) of not less than 14-gauge plate, but 10-gauge is recommended.

(c) Where the guard is placed within six (6) inches of a moving part, the openings in the mesh or plate should not be larger than ½ inch.

(d) Where the moving parts are less than six (6) feet above the floor or platform level, the guard may completely encase the moving parts on the top and sides instead of being made six (6) feet high, or a standard railing may be placed not less than fifteen (15) inches and not more than twenty (20) inches horizontally from the moving parts.

(e) When belts or shafting pass through the floor, the guard should extend to the floor and be equipped with a 6-inch toe-board around the floor opening.

(f) Drive Shafting and Gearing on Roller Tables should be covered with hinged metal covers over the top of shafts and with hinged aprons at the sides, or entirely encased.

Gears, Sprockets, Friction Drives, Keys, Set Screws

12. Gears, wherever located, should be completely encased or, where this is impracticable, should have a band-guard provided with side flanges extending inward beyond the root of the teeth.

13. Sprockets should be thoroughly guarded.

14. Friction Drives should be enclosed.

15. Spoke Hazards should be eliminated by enclosing or blanking the exposed side of the wheel.

16. Dangerous Projections on revolving shafts, such as clutches, keys, bolts, couplings, etc., which cannot be removed or made flush should be completely enclosed or guarded in such a manner as will prevent clothes catching on them.

17. Revolving Set Screws exposed to contact should be placed in safety collars, countersunk or covered by a guard.

18. A Starting and Stopping Device of an approved design should be provided for each power-driven machine.

19. Pulleys (including step-cone pulleys) should be equipped with belt shifters. These shifters should be permanent mechanical devices by means of which the belt may be shifted without touching it with the hand.

GASES AND LIQUIDS FOR WELDING AND CUTTING

GENERATING STATIONS

1. The regulations of the National Board of Fire Underwriters' should be followed in the installation of all generator equipment, and only apparatus approved by the Underwriters' Laboratories should be used.

2. All material or equipment should be rigidly inspected or tested before installation, and the installation of equipment should be done under the direction of thoroughly experienced men.

GENERATOR BUILDING

3. A separate building, located not closer than 10 feet from any opening into any other building, should be provided for housing the generator.

4. A separate room may be used if attached to outside wall and the separating wall is constructed of brick or concrete with no openings to other buildings.

5. The building should be constructed of fire proof material, preferably with brick, concrete, or tile walls, and sheet metal roof of light design.

6. The building should be of ample size to allow convenient room for recharging, inspection of parts and storage of a limited quantity of calcium carbide. (See requirements for Calcium Carbide Storage).

7. The floor under the generator should be of concrete 6″ thick, level, and provided with drain grooves to prevent corrosion and to allow circulation of air under the generator. The grooves should be 2″ wide, 8″ on centers, and 1″ deep at the back wall tapered to 3″ deep at the drain gutter. The floor other than under the generator should be concrete 4″ thick and sloped to drain gutter. The drain gutter for residuum should be located at front of generator and should be 7″ wide and pitched from 6″ deep at shallow end to 12″ deep at connection to acetylene pit. The gutter should be covered with ⅜″ steel or suitable cast iron plates.

8. Doors should be of steel and provided with locks to prevent unauthorized persons from entering the building. Doors should swing outward.

9. Windows should be of steel sash without ventilators and of sufficient size and number to provide ample light for inspection, repairs and recharging generator without necessity of artificial lighting.

10. Electric lights should be enclosed in guarded vapor-proof globes and all wiring placed in conduit, with junction fittings for all connections, so no bare terminals are exposed. Switches controlling the lights should be enclosed and placed on outside wall of building at a convenient location.

11. Continuous ventilation of the building should be provided by damperless ventilators in the roof.

12. Heating, when necessary to keep temperature of room to 40°F., should be by steam, hot water or other indirect system, but in no case should heater be located so that flame or fire is in or near generator building.

13. A charging platform with stairs should be provided at rear of generator for charging carbide. Platform and stairs should be of open type and provided with railings.

14. A carbide hoist consisting of tackle block with safety hook should be provided for raising carbide containers to charging platform. It should be located close to platform at end opposite stairs.

15. Residuum from generator should be drained to acetylene pit located outside of building. The pit should be connected to drain gutter by a 10" tile pipe. A movable standpipe with elbow at lower end connected to a 6" sewer through a bell trap should be provided from pit to drain off the clear water, and suitable method should be provided for removing the thick residuum from the pit.

16. A warning sign should be placed on outside of generator building with instructions that smoking is prohibited and that all fire and open lights should be kept away. If calcium carbide is stored in the same building, a sign reading, "Calcium Carbide—Do not use water to extinguish fire," should be provided.

17. All openings for piping through walls or floor of building should be sealed and made gas tight.

18. A carbon tetrachloride fire extinguisher of not less than one gallon capacity should be located convenient to the generator building.

ACETYLENE GENERATORS

19. Self compression generators which develop pressures above 15 pounds per square inch should be absolutely prohibited. Under no conditions should acetylene be used at a pressure greater than 15 pounds per square inch.

20. All generators should be plainly marked with the makers name and address, the number and type of machine, maximum rate in cubic feet of acetylene per hour for which they are designed, and the amount of carbide necessary for a single charge.

21. The installation of generators should be supervised by a man thoroughly experienced in this work. The instruction card furnished by the maker should be carefully studied and its directions followed in every detail.

22. Generators should be set level to prevent strains on apparatus or connections. (See No. 7, Floors—Under Building).

23. Instruction and warning cards provided by the maker should be posted in a well lighted place near the generator.

WATER PIPING

24. A 1½" galvanized water pipe should be carried into the generator room. Carry a full size line to water filling funnel of both generator chambers with piping terminating one or two inches above funnel. A valve should be provided at each water funnel.

25. A hose bib cock with about 25 feet of hose connected to it should be located at one end of the generator room for use in filling gas bell tank, holder seal pan, balance seal and hydraulic back pressure valve, and to flush floor and drain gutter.

ACETYLENE GAS SERVICE PIPING

26. Pipe, valves or fittings of any material, except copper, may be used.

27. Long sweep bends should be used when practicable.

28. Piping should be arranged to drain any moisture in the system to the generator or hydraulic back pressure valve. At low points in lines drip pots permanently closed with screw caps or plugs should be provided. No pet cocks should be used.

29. Pipe smaller than 3" may be welded without beveling, but for larger sizes the ends should be beveled about 45° to give 90° for welding. All burrs should be removed from inside of pipe at ends and holes, and care should be taken to prevent props of molten metal from running inside of pipe. The weld should be built up to reinforce the joint.

30. If screwed fittings are used joints should be made with only stringy white lead or shellac applied to male thread. Connections from generator to service pipes should be made with right and left thread nipples or long thread nipples with lock nuts or approved unions. Unions depending on gaskets to make them tight should be prohibited. Where lock nuts are used for connecting pipes they should be packed with graphite treated asbestos packing.

31. Screwed pipe should be standard, full weight, galvanized steel. Fittings should be extra heavy galvanized cast iron. Exposed threads should be covered with a non-corrosive coating.

32. Pipe lines should be tapped and carefully blown out with air or steam to remove all scale and dirt before being placed in service.

33. After piping is installed and before it is connected to the generator it should be placed under air pressure and the joints tested for leaks with soapy water.

34. All overhead and exposed pipe lines should be painted a distinctive color or marked with signs to avoid danger of mistaking these lines.

35. Gas cocks should be provided on pipe lines inside of all buildings near point of entrance where they can be conveniently reached so as to permit shutting off the gas supply from any building.

36. Pipe lines carried overhead should be well braced and secured by hangers. Vertical pipes should be firmly clamped to take the weight off of the horizontal line.

37. Outside piping should be run as direct as possible and should be carefully protected from injury. To avoid the use of traps, the lines should be laid so that the pipes are pitched to a low point without sags, and allowance made for expansion and contraction, jarring and vibration.

38. All underground piping should be laid in solid earth below the frost line and should not be placed in the same trench with, nor located near, other piping. Propping of the pipes on wooden blocks or sticks in the trench should be avoided. Pipes leading to surface should be cased or jacketed where necessary to prevent loosening or breakage.

Bottom of trench should be graded so lines will drain to drip pots. Drip pots should be placed in boxes to make them accessible. Underground pipes should be wrapped and covered with pitch. Fittings should be wrapped and pitched in place.

39. Each low pressure service line to each hose connection should be provided with an individual hydraulic back pressure valve for protection against back flashes. This valve also serves as a check valve to prevent the return of oxygen into the acetylene line due to a total or partial obstruction in the nozzle of the torch. The connections to the service line should be made with preferably a ½", but not less than a ⅜" pipe, each having a valve for shutting off each back pressure valve. Each back pressure valve should have a hose connection with screwed nipple for inserting in hose.

40. The vent pipes from several hydraulic back pressure valves may be connected to one vent line. The vent lines should terminate outside of the building, not less than 12 feet above the ground and not less than 10 feet from windows or other openings into buildings, and as far as possible from flues or chimneys. Their ends should be fitted with return bends or elbows opening downward. Both ends of vent lines should be extended to outside of building where practical. The vent lines, should be installed without traps and arranged so that moisture will drain to the hydraulic back pressure valves. Vent pipes should be full weight galvanized pipe with galvanized fittings.

PIPE SIZE CALCULATION

41. The following explanation and tables will serve to illustrate the method of calculating pipe sizes for acetylene service lines. First make a rough sketch of the proposed pipe lines and give each section a letter or number and indicate the location of the various welding stations by an "X" and cutting stations by an "O". Arrange a table with the headings shown, and then proceed to fill in the table as follows:

(A) In column 1, list each section by starting with the section nearest the generator. When the line divides in two or more directions start, a new group in the list. For example, "A" is grouped by itself, "B" by itself and "C," "D," "E" and "F" in a group.

(B) In column 2, list the feeder section for the first section of the group. For example, section "A" feeds section "B," "C" and "G".

(C) In column 3, list the length of each section, including both horizontal and vertical pipe.

(D) In column 4, list the total length of pipe from the generator to and including the section in question. The addition of the lengths of pipe can be simplified by referring to column 2. For example, the feeder section "H" is "G" so to obtain the total pipe for "H", add the length of "H" to the total for "G".

(E) In columns 5 and 6, list the number of welding and cutting stations to be installed in each section.

(F) In columns 7 and 8, list the total number of welding and cutting stations for which each section will be required to furnish acetylene. This listing can be simplified by starting at the bottom of the list and working upward. For example, section "P" has two welding stations, therefore, "N" must supply for two; since "M" has one station of its own, it must supply for three.

(G) In column 9, list the cubic feet per hour of acetylene that each section will be required to deliver, basing the calculations on the number of stations shown in columns 7 and 8. The acetylene consumption for the stations will have to be selected for the particular plant in which the installation is being made. In this example it has been assumed that welding stations will require 50 cu. ft. per hour and cutting stations 30 cu. ft. per hour.

(H) In column 10, list the pipe size for each section taken from the table of "Capacity of Standard Pipe for Low Pressure Acetylene." Under the heading "Length in Feet," find the length equal to or just above the total pipe length for the section in column 4, and on that line find the capacity equal to or just above the acetylene delivery required in column 9. The pipe size will be found at the top of the column above the pipe capacity. For example, for section "C" the total length in column 4 is 150 ft. and the acetylene delivery in column 9 is 220 cu. ft. per hour. On the line for 150 ft. of pipe, it is found that 355 cu. ft. is the nearest capacity above the 220 required and the pipe size at the head of the column is 2".

(I) In column 11, list the required or corrected pipe size for each section. It is obvious that if the pipe size in column 10 for a feeder section is smaller than a section it feeds, it is necessary to correct the feeder pipe size and make it at least equal to the section to which it feeds. To make these corrections, start at the bottom of column 11 and make sure that the feeder sections are at least equal to those which they feed. For example, in column 10, section "L" is 2½", therefore sections "K", "J" and "H", which are listed at 2", must be made 2½". Similarly, section "G", which is the feeder to "H" must be increased to 2½".

Tables

Section	Feeder Section	Pipe Section Ft.	Length Total Ft.	Number of Stations Section Welding	Section Cutting	Total Welding	Total Cutting	Acetylene Delivery Cubic Feet Per Hour	Pipe From Table	Size Required
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
A		50	50			12	4	720	2½	2½
B	A	100	150	2		2	0	100	1¼	1¼
C	A	100	150			2	4	220	2	2
D		50	200	2		2	4	220	2	2
E		100	300			0	4	120	1½	2
F		100	400		4	0	4	120	2	2
G	A	50	100			8	0	400	2	2½
H	G	50	150			5	0	250	2	2½
J		50	200	1		5	0	250	2	2½
K		200	400			4	0	200	2	2½
L		100	500	4		4	0	200	2½	2½
M	G	50	150	1		3	0	150	1½	1½
N		50	200			2	0	100	1½	1½
P		100	300	2		2	0	100	1½	1½

Capacity of Standard Pipe for Low Pressure Acetylene (Cu. Ft. Per Hour)

Length in Ft.	¾	1	1¼	1½	2	2½	3	3½	4	5	6
25	75	155	270	425	880	1530	2430	3560	4960	8600	13,500
50	50	105	190	300	620	1080	1710	2520	3520	6000	9,600
100	35	75	135	210	435	770	1210	1780	2490	4300	6,800
150	30	60	110	170	355	625	990	1460	2030	3500	5,500
200	25	55	95	150	310	545	855	1250	1750	3050	4,800
300	20	40	75	120	250	445	695	1030	1430	2400	3,800
400	20	35	65	105	210	380	605	890	1240	2080	3,280
500	....	30	55	95	190	345	540	790	1100	1900	3,000

Length in Ft.	¾	1	1¼	1½	2	2½	3	3½	4	5	6
600	....	30	55	85	175	315	500	720	1010	1780	2,800
800	....	25	45	75	155	270	430	620	885	1540	2,410
1,000	....	20	40	65	140	240	380	560	785	1370	2,150
1,200	....	20	35	60	125	220	350	515	705	1200	1,900
1,500	....	20	35	55	110	195	310	460	640	1100	1,740
2,000	....	....	30	45	95	170	270	385	555	950	1,500
2,500	....	....	25	40	85	150	240	350	495	840	1,330
3,000	....	....	20	35	75	140	220	325	450	760	1,220
3,500	....	....	20	35	70	130	200	300	410	720	1,120
4,000	....	....	20	35	60	115	180	270	380	665	1,050
5,000	....	....	....	25	60	105	160	250	340	590	940
6,000	....	....	....	25	55	95	150	220	310	530	840
8,000	....	....	....	20	45	80	130	200	270	460	740
10,000	....	....	....	20	40	75	120	170	240	430	670

HOSE

42. The oxygen and fuel gas hose should be of different color, or the couplings should be stamped for identification purposes, so as to avoid interchanging the hose. ⅜" double braid gray rubber hose should be used for fuel gas, and ¼" 6 ply, or three braid, high pressure red rubber hose for oxygen. Hose containing rubber reclaimed by the oil process should not be used for oxygen. Hose should be protected by an outer covering of tough durable material when used in service where there is danger of abrasion.

STORAGE FOR CALCIUM CARBIDE

43. Calcium carbide should be stored in a separate fire proof building or in a special room, constructed for the storage of carbide, in a fire proof building or room may adjoin the generator building but should have a separate entrance. No other material should be stored in the same room with carbide.

44. The building, or room, should be constructed preferably of brick, tile or concrete walls, and should be dry, water proof and well ventilated. There should be no openings in roof or walls except for ventilators and steel door. The door should be provided with a lock to prevent entrance of unauthorized persons.

45. Continuous ventilation of building, or room, should be provided by damperless ventilators in the roof.

46. Electric lights should be enclosed in guarded vapor-proof globes and all wiring placed in conduit, with junction fittings for all connections, so no bare terminals are exposed. Switches controlling the lights should be enclosed and placed on outside wall of building at a convenient location.

47. A warning sign should be placed on outside wall of building or room reading "Calcium Carbide—Do not use water to extinguish fire."

48. A carbon tetrachloride fire extinguisher of not less than one gallon capacity should be located convenient to the calcium carbide building.

49. Calcium carbide not exceeding 600 pounds when contained in approved metal packages of 100 pounds each may be stored in the generator room. All but one package should be sealed and the seals should not be broken on the other packages as long as there is carbide in excess of one pound in the open package in the room.

COMPRESSED COKE OVEN GAS

50. Coke oven gas may be used with oxygen for cutting if compressed to four pounds per square inch or over. Although compressed coke oven gas is not as dangerous as acetylene gas, the same precautions as provided for acetylene generator buildings should be followed in the construction of the compressor building.

51. The compressor should be of suitable design for compressing gas to a maximum of forty pounds per square inch and should be automatically controlled to prevent the pressure from falling below the minimum of four pounds or exceeding the maximum of forty pounds per square inch.

COKE OVEN GAS LOW PRESSURE PIPING TO COMPRESSOR

52. Pipe lines, either overhead or underground, should be provided with the necessary drip pots. A drip pot should be located next to the compressor on inlet side to remove water from line.

53. Joints may be made of any suitable material or compound.

COKE OVEN GAS DISCHARGE PIPING FROM COMPRESSOR TO PRESSURE TANK

54. The discharge line from compressor to pressure tank should be provided with an escape pipe, shut off valve and check valve. The escape pipe should be located between the compressor and the shut off valve, and the check valve between the shut off valve, and the pressure tank. No valve should be placed between the compressor and escape pipe. The escape pipe should extend through the roof and be provided with a safety valve on the discharge end.

55. The pressure tank should be of sufficient size to prevent excessive operation of the compressor, and should be provided with a safety valve and drain. The pressure tank may be located either inside or outside of the compressor building.

COKE OVEN GAS SERVICE PIPING

56. The gas line should have a shut off valve at the pressure tank.

57. The piping should be well supported and run to a convenient point and provision for connecting hose should be made with ½" pipe. Each pipe should have a valve for shutting off each hose connection. This valve should be fitted with screwed nipple for inserting in hose. The gas line should be tested and cleaned out periodically.

BU-TANE SERVICE PIPING

58. One or more cylinders of Bu-tane may be connected to a service line through a Bu-tane manifold system. When so used it is necessary to have only one regulator, or reducing valve, and one high pressure and one low pressure gauge. The regulator should be placed in manifold header and the outlet used for the service line connection. The high pressure gauge should be placed on the manifold header and the low pressure gauge on the service line. A gate or globe valve should be placed in the service line on low pressure side of regulator after connection to low pressure gauge.

59. The manifold should be made up of pipe and fittings of sufficient strength for the maximum pressure of bu-tane cylinders. The cylinders are connected direct to the manifold.

60. The service lines should be standard black pipe, preferably with welded joints. When screwed piping is used fittings should be extra heavy cast or

malleable iron. Joints may be made of any suitable material.

61. The bu-tane piping should be well supported and embody all features relative to construction, testing and marking, set forth for acetylene gas service lines. The connection for hose should be made with a ½" pipe, each pipe having a valve for shutting off each hose connection. The valve should be fitted with a screwed nipple for inserting in hose.

OTHER FUEL GASES AND LIQUIDS

62. Carbo Hydrogen, Pyrogen and Thermoline furnished in cylinders and employed for cutting, should not be used in connection with a manifold.

OXYGEN SERVICE PIPING

63. One or more cylinders of oxygen may be connected to a service line through an Oxygen manifold system. When so used it is necessary to have only one regulator, or reducing valve, and one high pressure and one low pressure gauge. The regulator should be placed in manifold header and the outlet used for the service line connection. The high pressure gauge should be placed on the manifold header and the low pressure gauge on the service line. A gate or globe valve should be placed in the service line on low pressure side of regulator after connection to low pressure gauge.

64. The manifold should be made of special seamless tubing of sufficient strength for the maximum pressure of oxygen cylinders. The cylinders are connected direct to the manifold.

65. The service lines should be standard black pipe, preferably with welded joints. When screwed piping is used fittings should be extra heavy cast or malleable iron and points should be made only with a mixture of litharge (yellow lead or oxide) and pure glycerine or thin shellac. Compounds containing oil, grease, or organic matter of any kind should never be used. Pipe and fittings should be heated after threading to remove oil.

66. Oxygen piping should be well supported, and underground piping should be laid in a separate trench below the frost line. All piping should be sloped so line can be drained if necessary.

67. Before the lines is used for oxygen it should be thoroughly washed out with soda solution consisting of one pound of caustic soda per gallon of hot water. The piping should be placed under pressure and the joints tested for leaks with water.

68. The connection for hose should be made with a ½" pipe, each pipe having a valve for shutting off each hose connection. The valve should be fitted with a screwed nipple for inserting in hose. Where necessary to keep oil and grease from hose at connection to valve, a sheet metal cover should be provided.

69. All oxygen service piping should be painted a distinctive color or marked with signs to avoid danger of mistaking these lines.

STORAGE BUILDING FOR FUEL GAS AND OXYGEN TANKS

70. A separate building, located not closer than 10 ft. from any opening into any other building should be provided for storing all fuel gas and oxygen pressure tanks.

71. A separate room may be used if attached to outside wall and the separating wall is constructed of brick or concrete with no openings to other buildings.

72. The building should be one story, without cellar or basement, and should be constructed of fire proof material, preferably with brick, concrete or tile walls, and a roof of light design.

73. The building should be properly ventilated and provided with a brick of concrete dividing wall for the purpose of completely separating the oxygen tanks from the tanks containing the fuel gases.

74. No windows or other openings should be provided in the roof or walls of the building except for ventilators and steel doors. The doors should swing outward and be provided with locks to prevent unauthorized persons from entering the building. Continuous ventilation of the building should be provided by damperless ventilators in the roof.

75. Large storage buildings should preferably be elevated and provided with a platform to facilitate and insure greater safety in handling tanks and equipment from trucks or cars. Where elevated a ramp, or inclined runway, should be provided from platform to ground to facilitate transporting equipment about the plant.

76. Racks of fire proof material should be provided in storage buildings for holding the tanks securely in place in an upright position.

77. The building should be provided with electric lights enclosed in protected vapor proof globes and all wiring should be placed in conduit, with junction fittings for all connections, so no bare terminals are exposed. Switches controlling the lights should be placed on the outside wall of the building at a convenient location.

78. If auxiliary storage buildings are provided at convenient points in the mill yard they should embody all of the above construction features.

79. A warning sign should be placed on outside of storage building with instructions that smoking is prohibited and that all fire and open lights should be kept away.

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The Economic and Social Development of the American Iron and Steel Industry*

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THE social and political character of any nation is largely dependent upon the extent of its economic welfare, and the prosperity of all classes of its people is contingent upon the prosperity of its basic industries.

Because iron and steel directly or indirectly enter into every form of human activity and touch the life of every civilized human being, the conditions surrounding its manufacture mirror to a marked degree those of business in general. This is particularly true in the United States, which has enjoyed unusual industrial activity during the last few years. A description, therefore, of some of the more important changes that have affected the manufacture of iron and steel may well serve not only as a text of the progress of the industry itself, but as a means of illuminating some of the reasons for American prosperity as a whole. If this contribution helps toward a better understanding of an economic and social situation, which during the last few years has been a source of widespread interest and investigation, its purpose will have been achieved.

Because of its subtlety current change needs time and distance for a proper perspective, and for the better comparison of the development of the United States in recent years a chronological base line has been established at the ushering in of the twentieth century. While this discussion is thus specifically concerned with the development of the last twenty-five years, the prelude of an earlier background may throw into stronger relief some of the conditions and forces that are in play today.

As late as 1860 manufacturing in the United States was chiefly confined to comparatively small units located in the communities that fringed the Atlantic seaboard. Transportation was slow and costly, and distribution was largely for local consumption. Industrial ownership lay in the individual, partnership, or small corporation, and there was close contact between men and management. Wages and output were low, luxuries few and far between, and standards of living were relatively simple.

Then came the epoch-making pneumatic process for making steel. It was the beginning of the industrial revolution which has made America the great workshop that it is today. The iron and steel industry was quick to grasp the possibilities of the new process, and steel plants began to spring up here and there throughout the country. By the Bessemer rail the Far West was opened, and the North and South were tied together. For thirty years unparalleled expansion followed the rapid development in railway construction, and men swarmed to American shores in response to the call for labor.

By 1880 manufacture was rapidly forging to the front. Individual ownership of the shop was giving way to the small corporation, and the small corporation to larger aggregations of capital. The former employer was becoming the employe, and there was less personal touch between owners and workmen.

With better and more extensive transport facilities industry became more highly centralized, and rural life was replaced more and more by urban life. The relative crowding of industrial centres helped to accentuate the change from former standards of living, and the transition was not always conducive to contentment and well-being. Factory conditions were crude and too often unsanitary, and the physical hazard of industry rapidly grew through the increased installation of power and machinery.

A class consciousness developed to an extent unknown before. The country was becoming richer, and with increased wealth capital was prone to be more intolerant and labor more independent, while both gave less heed than formerly to the power of public opinion; but in spite of these throes of a new industrial birth the country continued to expand.

In reviewing this period it is clear that the underlying reason for the remarkable progress made in the twenty-five years following the close of the Civil War in 1865 was the introduction of the Bessemer process. No single industrial invention ever had such a vital and far-reaching effect on the commercial and social destiny of any nation as this new steel-making process had upon the United States. The first Bessemer ingot made in the New World was produced at an experimental plant at Wyandotte, Michigan, in 1864, but steel did not begin to be an important factor in the replacement of iron till ten or fifteen years later.

When the Illinois Steel Company was organized in 1889, with an authorized capital of $25,000,000, by the combining of three important steel-producing companies in the Chicago district, it was properly heralded as an outstanding feat of corporate development. It represented at that time the most forward step in individual control of pig iron and steel-producing plants, but even in this case the company lacked complete operation, and had largely to depend upon outside parties for their ore and coal supply. As with other large steel producers in that period, the finished product chiefly consisted of rails, while the blooms and billets, which mainly made up the balance, were but the raw material for finishing mills belonging to other interests.

The following ten years from 1890 to 1900 were momentous in their import to the country, and were fraught with consequences that were fundamental in their influences upon the present life of the American nation. This period recorded the true beginning of big business, and iron and steel again played the most important role. The first seven years of the decade beginning with 1890 were lean and hungry. The necessity of rigid economy was emphasized by the severe industrial depression that existed. Liquidation became general and drastic, and by the time the pendulum swung toward brighter things the

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country was ripe for the saving and profit that lay in combination.

In 1898 the Federal Steel Company was formed with an authorized capital of $200,000,000. This brought under one management ore, coke, iron, steel, and transportation, to an extent only approximated by the Carnegie Steel Company. During this period most of the finishing mills throughout the country were brought together into large units, and they controlled in their separate entities the wire, tube, tinplate, hoop, and sheet steel products of the country.

Such consolidations in iron and steel were largely typical of the change that was taking place throughout the manufacturing industry as a whole. It was a time of feverish activity. Promotion was rife, business ethics were low as compared with present standards, and as a result of public mistrust there was a marked change in Federal and State legislation from one of permission to one of restraint.

The Dawn of the Twentieth Century

The twentieth century opened auspiciously for the United States amidst long-deferred prosperity. The rapid rogress made in the period just reviewed was founded upon new processes and new methods, distinctly technical in their character, which followed the introduction of the manufacture of steel.

The progress during the last twenty-five years, however, has been more essentially the result of social and economic change. Its history is a story of a nation adopting and assimilating the principles of big business; of the mobilization of its capital and credit through the Federal Reserve system; of increasing its industrial output through co-operation, integration, and mechanical energy; of developing modern management as an entity separate from owner and worker, and of more equitably dividing among its people the fruits of industry through better opportunity and higher wages. In short, the story of the first quarter of the twentieth century is one of a nation commanding for its people the highest standards of living ever achieved by any nation by the scientific study and application of man and machine.

During the last twenty-five years the income of the United States has nearly doubled, while its population, though largely increased, has grown in a lesser ration. The significance of these changes lies not so much in the increase in the nation's production of wealth as a whole, as in the surplus purchasing power that has sprung from the increased output of the individual worker. A large family may produce in the aggregate much more wealth than a small one, but if the large family accumulate no surplus, a small family with greater individual productivity and with the same proportionate cost of living may grow rich while the large one remains poor. A vital factor in the development of the twentieth century, and one which has been especially emphasized in the United States since 1914, is the multiplication of individual effort rather than the effort of multiplied individuals.

The United States during the past few years has been experiencing the unprecedented economic condition of continuously falling commodity prices, high wages, and continued prosperity. Any intelligent attempt to explain this anomaly must recognize certain elementary economic principles.

It is clear that wealth cannot be divided until it is produced, and obviously the more there is produced by each workman the more there is to be divided. Wages and dividends are primarily matters of wealth's distribution—not of its production. High wages mean high consumption. The larger the output of the individual workman, the greater is the tendency to lower costs and the greater the possibilities of return in wages and in dividends. Present easy money and low inventory are factors that influence but do not answer the question before us. High wages as a matter of distribution instead of production are an effect rather than a cause, and raw material, of which our forefathers had much more than we, is but of potential value until converted.

These are elements that enter into a complex problem, but do not explain it. Neither would increased production if accomplished merely by a proportional increased in the number of workers. The true answer to this economic paradox of combined high wages and lowering prices of goods, and the underlying primary cause of the late industrial progress of the United States, lies in the increased and unrivalled output of the individual American workman, and the large accumulation of wealth that has resulted from it.

The extent of this wealth is indicated by figures recently compiled by the National Industrial Conference Board from Washington statistics. These show that the value of the yearly product of the average workman in all the manufacturing industry of the United States rose from a per capita production value of $3214 in 1904 to $4682 in 1925, as measured by the common purchasing power of the 1914 dollar. This represents an increase of 45.7 per cent. in the manufacturing output of the average individual workman, which if applied to the total volume of manufactured product signifies that the increase of wealth in 1925, due solely to the increase in per capita production, amounted to $12,304,000,000 more than it would have been had the output of the average worker been no greater than it was in 1904; in other words, one-third of all the wealth that was produced that year from the nation's manufacturing industry was directly due to the increased productivity of the average individual workman.

How profound an influence such vast sums have on the whole economic structure of the country is perhaps better visualized when it is realized that twelve and three-tenths billions of dollars, on the basis of present individual production, is equivalent to the output of 2,628,000 men—a number equal to nearly one-third of the entire working force of the United States engaged in the manufacturing industry. That the productive efforts of such a vast army of workers can be laid aside by machinery and management and rendered available for other additional work without an average increase in the country's non-employment is a striking commentary on the stimulating and absorbing effect of increased individual production.

The average output of the individual workman in the United States is to-day greater than ever before, and is much larger than that of any other nation. Canada comes next to the United States in individual productivity, and American finds its antithesis in the archaic industrialism of China.

An explanation of the increased efficiency attained by the manufacturing industry of the United States is

found in the development of its iron and steel production. Of all basic industries the manufacture of iron and steel ranks first in fundamental importance and second in the amount of wages paid.

Production of Iron and Steel

In 1901 the United States with its output, in round numbers, of 13,500,000 tons of ingots and castings, produced 44 per cent. of the world's steel. This by 1926 had expanded to more than 51 per cent. of the world's total, with its production of over 48,000,000 tons of steel. Whereas twenty-five years ago the steel ingots made in the United States consisted of more than 66 per cent. acid Bessemer, nearly 84 per cent. of the steel now produced is of basic open-hearth. This, in brief, tells the nation's accomplishment for the first quarter of the century, and records the large replacement of the Bessemer converter by the open-hearth furnace, a change superinduced by the changing character of the country's ore reserve.

The causes for this impressive growth, while clearly complex, are largely predicated upon economic and social change rather than upon any pronounced technical difference in method of manufacture. In principle, the blast-furnace, open-hearth, Bessemer converter, and rolling-mill are still the unchanged agents of reduction and conversion, and there has been but little progress made in the fundamental metallurgy of iron and steel during the twentieth century. Momentous advances in technique and the refinement in operation have resulted in an increase of output which can only be partially attributed to a multiplication of plants.

The production records of the past twenty-five years at the South Chicago Works of the Illinois Steel Company furnish a concrete illustration of the effect of such advances. These works represented in 1901, as they do now, the best modern practice. The average daily output of each of the South Chicago blastfurnaces increased from 318 tons in 1901 to 679 tons in 1926. During this period the acid Bessemer department increased its production from 70,000 tons to 100,000 tons per month, and the basic open-hearth furnaces increased from an average output per furnace of 586 tons per week to 1379 tons per week. The South Chicago rail mill had an average capacity of 60,000 tons per month in 1901, while the Gary rail mill, by which it has been replaced in the rolling of rails, has a capacity of 100,000 tons per month. These figures reasonably illustrate the unit advance in physical production which has taken place in the iron and steel industry in the United States.

A still more important development in American practice is the increased per capita output of the average iron and steel workman. This is strikingly illustrated by the following South Chicago records:

ILLINOIS STEEL COMPANY (South Works)

Tons produced per Man-Hour

	1902	1926	Increased Percentage
Ore unloading	2.087	16.835	706.7
Blast-furnaces	0.185	0.698	277.3
Bessemer ingots	0.421	0.841	99.8
All open-hearth ingots	0.252	0.418	66.0
Rail mill (South Works, 1902)			
" " (Gary Works, 1926)	0.189	0.416	120.1

This table shows that the average man in a modern iron and steel plant is producing from 1½ to eight times as much as he did twenty-five years ago. If translated into yearly volume, these figures indicate that at South Chicago the average workman has increased his ore-handling capacity since 1902 from 6000 to 48,000 tons; his pig iron output from 675 to 2405 tons; his Bessemer ingot production from 1761 to 3730 tons; his open-hearth ingot production from 1049 to 1842 tons; and his rolling capacity from 603 to 1240 tons of rails.

That this accomplishment is fairly typical of the changes that have taken place in like branches of the industry for the country as a whole is supported by data lately published by the United States Department of Labor, which shows an average increase in worker productivity upon a man-hour basis of 165 per cent. from 1899 to 1926 for crude iron and steel products.

These results are impressive when it is recalled that they are based upon actual continuous records running over a quarter of a century in a plant which in 1901 represented the latest development in equipment, organization and method, and one that during the intervening years has kept abreast of current change.

Such a transformation is essentially due to the enlargement of units, refinement of design, and the installation of labor-conserving appliances rather than to fundamental changes in process. Behind these, however, is the large addition of mechanical energy by which these improvements have been made possible, and at the back of all lies enormous investment and cooperation of men and management.

Power Installation

The manufacturing productivity of any nation can be roughly measured by the amount of its mechanical energy, and the marked growth of power application in the United States has made possible its expansion and prosperity. From 1899 to 1925 the country's primary horse-power more than trebled, and as a result of this increase there is now 4¼ horsepower at the service of every manufacturing wage-earner.

On the conventional assumption that one horsepower is equal to the unassisted physical effort of ten men, the average capacity of the individual worker in the United States is more than forty times what it would be if unaided by mechanical energy.

The manufacture of iron and steel has more than kept pace in power installation with the progress made in general industry. During the last twenty-five years its use of power has increased nearly fourfold, and to each of its workmen there is now given the energy of over sixteen horse-power.

The extent to which power usage has been amplified and the electrification of plant increased is strikingly exemplified by the Gary Works of the Illinois Steel Company. A short generation ago the reciprocating steam-engine was the principal prime mover in both primary and secondary units. At Gary the production and utilization of power is dependent upon the blast-furnace gas-engine, steam-turbine, electric generator, and motor. Here 11,716 men were able in 1926 to turn out more than 2½ million tons of finished product, because behind each of them was the electrical energy of nearly twenty horse-power.

Wages and their Relation to Living Cost

It is but natural to ask whether or not the increase in worker productivity, in which power usage is such an important factor, has been followed by an increase in "real wages." Wages and earnings in the Chicago district may be considered as typical of those existing elsewhere in the iron and steel industry of the country. In 1901 the daily wage was based on fifteen cents per hour, and the average yearly earnings of all employees of the South Chicago Works for that year was $825. By 1926 the hourly rate had risen to forty-four cents, and the average yearly earnings to $1870, an increase of 127 per cent., or more than double the amount of earnings received before. With this increase in earnings went also a reduction of nearly 18 per cent. in the hours the men were required to work. Prior to 1922 the iron and steel industry had been operated almost universally on the basis of twelve hours for continuous operations, and ten hours for non-continuous operations. In that year the present eight and ten-hour day working schedule was adopted, and several years earlier the seven-day week had been replaced by the six-day week.

In the first decade of the century there was no striking change in the basic cost of living or in the wage scales. By 1914, however, there had become pronounced that vicious circle of high commodity prices, high cost of living, and high wages which a few years before had begun to evidence itself. War conditions aggravated the situation, and commodities, living costs, and wages rapidly pursued one another upward in an ever-expanding sequence until the deflation of 1921. The social and economic consequences to the wage-earner and to industry are told by the following result of governmental investigation. Earnings in twenty-three representative industries increased 115 per cent. between 1914 and 1925. Living costs of workers' families rose 68 per cent., and the hours of labor decreased more than 6 per cent.

These figures indicate that wages in the manufacturing industry have more than kept pace with the increase in commodity prices. The surplus earning power thus represented well explains the present wide consumption of luxuries and the high standard of living that now exists.

Prices and Investment

Granting that the economic change during the last twenty-five years has been distinctly beneficial to the wage-earners, what has been the contemporaneous effect upon the consuming public and investor?

If we take the price relation that existed between the composite steel price and the wholesale price of commodities in 1913 as a base, we find that whereas in 1901 the price of steel was relatively 52 per cent. higher than that of commodities, it was in 1926 3 per cent. lower. The composite price of steel is now practically 27 per cent. higher than in 1901, while the wholesale price of commodities has increased 99 per cent. Due to efficient management, the spending of many millions in power and machinery, and the co-operation of labor, the consumer, relatively speaking, is buying steel now cheaper than he did twenty-five years ago.

With the investor of to-day it is a somewhat different story, and this is especially true if there be borne in mind the difference in the amount of money represented by capitalization upon which dividends are paid, and the much larger sum that is represented by the balance-sheet, and upon which earnings are dependable.

While there are from the Government no exact figures of the amount of money that is now invested in the iron and steel industry, the published balance-sheets of steel companies representing over 85 per cent. of the country's ingot capacity show a capitalization of approximately 4½ billion dollars. According to these reports, earnings for the years 1925 and 1926 are respectively 5.61 and 6.70 per cent. on the capital invested. It thus appears that while the wage-earner, the consumer, and the public in general have been very distinctly benefited, capital has not fared so well.

Increase in Steel Capacity

Due to the exigencies and stimulation of the war, the ingot capacity of the United States increased slightly over 15 million tons for the six years 1915 to 1920 inclusive, or at the rate of approximately 2½ million tons per year.

The end of the war left the country with excess plant development, and for six years subsequent to 1920 the total ingot capacity increased less than 3½ million tons, or at the approximate rate of half a million tons per year. The theoretical steel ingot capacity of the nation is to-day, in round numbers, 58 million tons. While during the war no expense was spared to enlarge the country's steel capacity, investment during the last six years has been made with special reference to the reduction of costs, diversification of product, and the betterment of quality instead of increased production.

This explains why the installation of power and labor-saving machinery has been of late so strongly emphasized, and why there has been such heavy scrapping of inefficient and obsolete machinery and plant. Irrespective of its physical condition of its length of service, it is not good business to continue to use machinery if a better design will pay a fair return on its investment by reducing costs. The American practice is drastic in this regard, and it is only by such a progressive policy that any concern or any nation can hope to keep abreast of the times and successfully maintain its position.

But given the vision and courage to adopt such a polity, whence comes the capital with which to finance such undertakings? It may be trite to recall that capital practically speaking, is but earnings saved, but it is perhaps not so obvious that the amount of saving largely depends upon the surplus output of the individual. Because this surplus has been gradually expanding for many years through reproductive effort and reproductive investment, not only has wealth grown but its distribution is wider than ever before.

The nation's savings deposits of over 24½ billion dollars, with its 46¾ million depositors, is an index of the extent to which capital has been distributed, and the long lists of small stockholders in industrial corporations illustrate the rapidly growing character of its investment. The aggregate wealth of the United States no longer lies in the excessively rich, but in the

small property owner whose name is legion, and more and more does management represent and stand between him and concentrated ownership.

Management

Just as the exigencies of expanding business fifty years ago resulted in the small corporation taking the place of individual ownership and control, so their resulting economies brought into existence the larger corporations of to-day. In the last two decades of the nineteenth century there was not always a proper appreciation of the difference in power and responsibility between large and small aggregations of capital. Management was then apt to measure responsibilty and success by the profits it made rather than by the methods it employed. The rights of the public, the competitor, and employe were oft-times neglected; monopoly was not always discountenanced; labor was sometimes exploited; prices were apt to fluctuate from exorbitant heights in good times to ruinously low figures in bad times; competition was frequently destructive, and business ethics too often failed to square with the golden rule.

Such principles and methods of doing business fell into disrepute years ago. Management learned that the difference between monopoly and unreasoning competition is the difference between ephemeral success to the few and industrial suicide by the many, that the exorbitant profits of a peak demand were offset by the losses of succeeding reaction, and that stability in price helps stability in operation.

To-day modern management stands not as the representative of capital alone, but as an entity representing the interests of the public, the stockholder, and the employe. For the development of this sense of plural trusteeship and the creation of the new spirit of cooperation that now animates all well-managed American concerns, the management of the United States Steel Corporation is in no small measure responsible.

The United States Steel Corporation commenced business on April 1, 1901, with a capital structure of nearly 1½ billion dollars. It represented a merger of ten large companies, each prominent in its own field. It was a consolidation of consolidations, most daring in its conception and destined to be monumental in its achievement. Its initial capacity in steel ingots and castings was 9½ million tons, which comprised 65 per cent. of the country's total output. To-day it represents but 45 per cent. of the nation's tonnage with its production of 23 million tons.

At the time of its organization the failure of the enterprise was freely prophesied because of its colossal size. The public was suspicious of its monopolistic potentiality. Organized labor dreaded its power, and rivals feared possible unfair competition. During its existence it has twice been seriously attacked by organized labor, and for years it was in the courts because of the Government suit brought for its dissolution.

In spite of dire prophecy and unjust attack the corporation, after more than a quarter of a century of constructive effort, not only stands to-day absolved by the Government and the people of unfair practice, but is recognized throughout industry as an exemplar of efficiency and high business standards.

Since the beginning of the United States Steel Corporation Judge E. H. Gary has guided its policies. To him is largely due that publicity in corporate affairs which principally found its birth in the innovation of regular and detailed statements of the Corporation's activities. To the public the Corporation's policy has meant reasonable prices and knowledge of the Corporation's results; to its competitors, co-operation and a stabilizing influence; to its employees a more generous return than ever before paid by the industry; and to its stockholders a fair return on their investment.

In management as in other departments of American industry the job seeks the man, and character and ability are the determining factors. Perhaps nowhere is the success of this dominant policy more strikingly illustrated than in the leaders of America's two largest corporations in the steel industry. The character and accomplishment of Elbert H. Gary and James A. Farrell of the United States Steel Corporation, and Charles M. Schwab and Eugene G. Grace of the Bethlehem Steel Company, chief executives and presidents respectively of their corporations, need no elaboration here. Their prestige and resource is distinctly an heritage of ability and hard work, and their history symbolizes to a marked degree American opportunity and American accomplishment.

Labor

Because of the large increase in the number of small investors the line of demarcation between so-called labor and capital is rapidly lessening. There is a better appreciation to-day that the nation's capital is principally the savings of labor's thrift and is largely owned by labor itself. With the dissemination of this truth has also gone a better realization that in American industry the labor of the office and counting-room is in the same economic category as the labor of the mill or field, and that the officials of management are just as truly employees of the corporation which hires them as the men working under their direction.

The composite American workman is of a high order of intelligence, peculiarly free from traditional bias and restraint, and welcomes as a rule mechanical assistance for the increasing of his output because of its greater attendant earnings. He is especially jealous of his right to freedom of action, is quick to resent unjust treatment, and does not hesitate to change the character or place of his employment if dissatisfied or if better opportunity presents. He resents political and organized domination, and prefers his own negotiations to bargaining by representatives.

That these statements reasonably reflect the general character of the largely predominating mass of skilled and unskilled labor in the United States to-day is demonstrated by the fact that attempted political dictation by organized labor even in their own ranks has been a failure, and that the United States is essentially an open-shop country. Of the 117,000,000 of its inhabitants about 44,000,000 are "gainfully" employed, and of these about 8,500,000 are found in the manufacturing industry. Organized labor has in its enrollment something less than 4,000,000 workers, and these are principally found in the mining, transport, building, and textile industries.

Formerly when short-sighted management oft-times led to the oppression of the worker, and when co-

operation between employer and employee was more stressed by its breach than by its observance, organization of labor grew rapidly, because of its protective appeal to the individual. To-day, however, a better understanding of common aims and a clearer knowledge that even armed neutrality is unprofitable, has resulted in an appreciable lessening of interest on the part of the worker in labor organizations, as is indicated by a reduction in the membership of the American Federation of Labor from 4,078,740 in 1920 to 2,803,966 in 1926.

The iron and steel industry of the United States is operated on an open-shop basis. Employment is not concerned with nationality, politics, religion, or union affiliation; and plant representation, negotiation as to wages, and methods of work are distinctly between the management and the men, singly or collectively, and not through outside agents.

An exception to this general rule is found in a few small mills where the Amalgamated Association of Iron and Steel Workers is still recognized. That their influence is small is indicated by the fact that while the iron and steel industry employs about 400,000 men, the Amalgamated Association's enrollment has fallen from a membership of 14,035 in 1900 to 11,174 in 1926.

Some of the American labor unions have maintained their position through conservative leadership and the rejection of radicalism. More, however, have lost ground by attempting militantly to force domination on peaceful industry and by insisting on wages, hours, and rules that were unfair to the public because out of harmony with economic principles and existing conditions.

It is one thing for labor or for management to use its might to right a wrong. It is another thing to disrupt a community or a nation for selfish aggrandizement, and American public opinion has thus far refused to sanction special privilege to either labor, management, or capital.

As a result of this attitude both management and labor have found that fair dealing is remunerative as well as ethical; and that co-operation is more productive than oppression. That there has been of late years much better co-operation on the part of the vast majority of the labor body is by no means solely due to the higher wages that they have received. Management early in the century began more practically to recognize their obligations to the human side of industry. It found that the minimization of occupational hazard, sanitary surroundings, hospitals, better housing, and other welfare work which promoted the health and happiness of the worker and his family, was not only humane, but paid by the goodwill and the co-operative spirit that it inculcated. In the development and application of this new science of human engineering the iron and steel industry, inspired by the example of the United States Steel Corporation, has taken a most prominent part.

In 1906 the United States Steel Corporation inaugurated a campaign of safety, sanitation, and welfare which has ever since been vigorously pursued. Tonnage and costs became no longer the sine qua non of achievement, and the safety and welfare of the worker is a vital consideration in mill operations.

Accident prevention has naturally been most prominently stressed. The safeguarding of machienry starts with the drafting board in all construction, and is diligently pursued thereafter as experience permits. Education and organization of men into safety committees plays an important part, and that expense is not allowed to interfere with the desired object is indicated by the expenditures by the United States Steel Corporation last year of 1¾ million dollars in safety work.

As a result of such intensified effort extraordinary reduction in the accident rate has been achieved. Among the quarter of a million men employed by the United States Steel Corporation in 1926 the rate of disabling accidents was 3.26 per cent. as compared with 20.57 per cent in 1912, or a reduction of 84.15 per cent. of the former rate. That means that in the company 365,277 men have been saved from disabling injuries since 1912, as measured by the sum of the reduction in accidents each year.

In addition to the payment of liberal wages various corporations seek to improve the financial condition of their employees by affording them the privilege of stock subscription on advantageous terms. In the United States Steel Corporation, in illustration, there were 47,647 employees registered as stockholders as on December 31, 1925, who held 665,801 shares of the Corporation's preferred and common stock, with an aggregate value of over 100 million dollars. Like the Corporation's safety and other welfare activities, this method of encouraging a partnership relation is absolutely divorced from any paternalistic method or condition, to which both men and management rightfully object.

Consumption and Markets

At the beginning of the century the United States, with a population of 76,000,000 people, produced 9½ million tons of finished steel, while in 1926, with a population of 117,000,000, this output had risen to 35½ million tons. In other words, each inhabitant as an average used 739 lb. of finished steel in 1926 as compared with 279 lb. in 1900, or over 2½ times more now than formerly. This expansion is essentially due to increased domestic demand, and has been but little influenced by the small percentage of growth in the country's foreign trade. The following statistics show how small this change has been. The iron and steel imports and exports of the United States, in round numbers, were respectively 200,000 tons and 1,000,000 tons in 1900 as compared with imports of 1,000,000 tons and exports of 2,000,000 tons in 1926.

The increasing ramifications of steel's new uses are continually making for widening markets. With greater diversification of product has come an insistent demand for quality, so that to-day trade requirements are infinitely more severe than in former years. The comparatively rapid growth of alloy steels and the increasing call for electrical refining is a result of this demand, and such special steels are an important and growing factor in the economic progress of the country. The change in the character of the demand is illustrated by the item of rails. At the beginning of the century the production of rails absorbed 25 per cent. of the country's entire steel output. Last year, although the rail tonnage was half again as large as it was twenty-five years ago, it represented only 9 per cent. of the country's steel production.

In the new demand for steel the most important development is the expansion of the automotive industry, which last year took 15 per cent. of the nation's output.

In the development of this industry the accomplishment of Henry Ford is outstanding. To his genius, courage, and vision we must pay high tribute when analyzing the effect of high production and the increased per capita production that has followed his methods. To his doors has come the world to study the specialization of men and machines, and his practice and high wages have been made prosperity's text by various international expounders of economic and social conditions. But while industry owes much to Mr. Ford, his methods and his results may easily lead to false conclusions if superficially studied. Thanks to his foresight and inventive genius, he produced a car which in its sturdiness and its low price so far outclassed his competitors as to amount temporarily to a monopoly. With an almost insatiable public demand, his profits, though legitimately made, were so large as to put his enterprise outside the pale of ordinary competitive conditions.

It is as a monopoly, not as a competitive industry, that Mr. Ford's past achievement must be studied if proper deductions are to be drawn. The present intensive competition by powerful interests, in low-priced models, promises to emphasize this fact.

Between the manufacturers of steel in the United States there is free exchange of ideas and information in respect to equipment and practice, and former secrecy has given way to a courteous welcome to both foreign and domestic competitors. In the matter of sales, however, while information concerning prices may be legally exchanged, anything in the way of price agreement or restraint of trade is outside the law. Although industrial combination carries with it the possibility of service to the community by saving in operation and saving in distribution, it may also carry with it the possibility of unreasonable prices. That the public in the United States feared the possible monopolistic power of the industrial merger more than it appreciated its constructive force is evidenced by the Sherman anti-trust law and the subsequent anti-trust legislation that has been enacted. The difference between governmental encouragement of the cartel in Europe, and the discouragement of industrial combinations in the United States is, therefore, a difference in the public state of mind. That the United States laws against trade agreement and in favor of unrestricted competition are economically sound is subject to grave question. That uncontrolled licence to combine would be in the long run more economically sound is likewise open to doubt. Possibly a happy medium could be found in permissive regulation. In any event, President Coolidge's dictum of more business in government and less government in business rings true in the light of general experience.

SUMMARY

The economic progress or retrogression of any nation depends upon the expansion or curtailment of the individual production of its workers, and the secret of America's well-being lies in its unrivalled per capita output.

At the back of all accomplishment, however, is human effort, and the installation of power and the wealth of material resource will be but abortive aids unless utilized and directed by the hand of able and willing labor.

The character of any people depends upon their education and environment, and their material welfare can only be assured if founded upon sound economic methods. The irrevocable law of supply and demand is nothing but human nature reduced to a formula, and composite human nature is unchangeable in its primary instincts in spite of civilization's veneer.

Consumption is vitally affected by costs of production, but for management to lower costs by reducing wages if they are reasonable is just as shortsighted as for labor to try to improve its condition by restricting its output. Both, if continued, must inevitably lead to lower standards of living.

High wages and high dividends can only come from high production, and high production will be better assured if labor is not only paid to produce but also is paid by what they produce. Tonnage rates, piece-work, and bonuses for favorable performance spell high earnings when justly formulated, and American production owes much to this enlightened method of labor remuneration.

Prosperity to continue must be based upon a thriving public, contented labor, and adequately remunerated capital. If any one of this essential trinity becomes unbalanced the wheels of industry will slow down and prosperity disappear.

As a prophet may not be without honor, save in his own country, the author ventures the prediction that as war has given way to peace, so will ignorance give way to economic enlightenment, and that in the new spirit of industrial co-operation there will be found both greater prosperity and a better understanding between the nations of the earth.

*10-Ton Overhead Traveling Crane**

A 10-TON, 60-foot span electric overhead traveling crane, constructed entirely by means of arc welding has recently been constructed by The Cleveland Crane & Engineering Company, Wickliffe, Ohio. While arc welding has been extensively used in the manufacture of heavy duty material—handling equipment, it is a decided innovation to build a complete crane of this type without the use of rivets.

In discussing this crane, Mr. Wehr, General Superintendent refuses to call this type of construction an experiment. "We have," he states, "simply applied arc welding to this job in accordance with sound engineering

*Prepared by Cleveland Crane & Engineering Co., Wickliffe, Ohio.

principles and along lines which we have proved to ourselves to be correct."

"We know that an arc-welded joint can be made stronger than a riveted joint because the metal can be more advantageously applied. We designed this crane for arc welding, first, to secure the greatest possible rigidity with the same weight of steel and second, in order to incorporate several new features which increase the speed of acceleration of both trolley and bridge travel. Furthermore, we believed that certain features in this crane would reduce the power consumption."

The details of construction of the bridge girders will be of interest. Each girder is of the fish-belly, box type consisting of two webs and top and bottom cover plates. Both cover plates are arc welded to the webs by a fillet bead of welding metal. Some slight difficulty was experienced here due to expansion which tended to distort the plates. This was overcome by using the

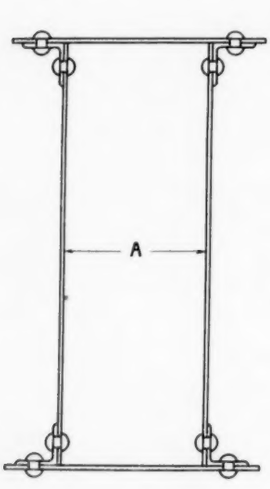

FIG. 1.
CROSS-SECTION OF RIVETED GIRDER

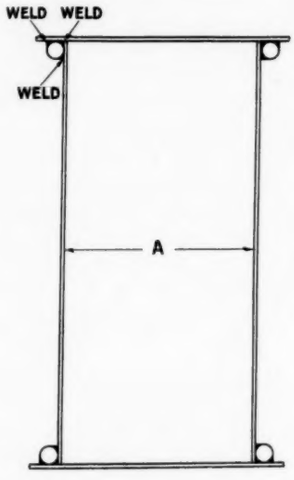

FIG. 2.
CROSS-SECTION OF ARC-WELDED GIRDER

stepback method of welding a short distance at a time and then allowing the metal to cool before resuming at that point.

This weld in effect makes the two webs and the top and bottom cover plates an integral box section of steel with the joints as strong as the plates themselves. No such rigid connection is possible by riveted construction.

However this joint is not relied upon to take the entire stress in the girder. It is simply an auxiliary connection to give maximum rigidity. In addition to this weld still greater strength is secured by welding a round bar along the webs and cover plates at each of the four corners of the box section.

This is shown by the sketch.

The area of this round bar is equivalent to that of the angle section which would ordinarily be employed in riveted construction. Since the stress in this bar is pure tension on the bottom of the girder and compression at the top of the girder it is apparent that a round section is at least as efficient as an angle section.

The chief advantage of this construction over riveting lies in the manner in which the reinforcing member is attached to the plates. Instead of depending upon the strength of rivets of possibly ¾ inches in diameter, spaced at 3 to 4 inch intervals, the reinforcing bar is welded to web and cover plates by a continuous bead for a distance of 60 inches from each end of the girder. Throughout the remaining length of each girder the bar is then joined to the plates at intervals of 3 inches by beads 4 inches in length.

Bridge girders are reinforced by the customary diaphragms spaced at suitable intervals. The diaphragms are fillet welded to both webs and to the top cover plates, thus dispensing with flange angles. It has been

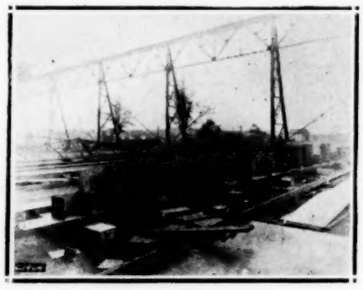

FIG. 3—View showing inside construction of crane girder. Note how stiffening diaphragm are arc welded to top cover plate as well as to web plates.

demonstrated that the fillet type weld can be made to develope unlimited strength by simply depositing enough metal to give the required section. On this crane the fillet welds were figured to give a strength slightly greater than that of the plates.

There is some slight saving in weight made by eliminating the flange angles on the reinforcing diaphragms but this is not particularly important. The chief point of interest is that the diaphragms are rigidly attached

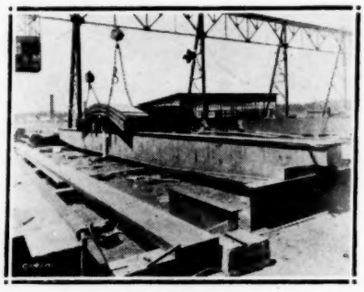

FIG. 4—Girders were tested by supporting them at each end and applying a load at the center. The normal load for each girder is 5 tons. A test load of 17½ tons was applied without any permanent deflection.

to the top cover as well as to the webs which is not usually the case with riveted construction.

No attempt was made in the design of this crane bridge to take advantage of possible saving in weight of plates which is permissible by arc-welded construction. In other words, plate of the same thickness was used as would have been used for riveted construction where the weakest point is along the line of rivet holes. While undoubted economies could be made, the sole object of this design is to produce the rigidest possible

bridge within the weights customary for a crane of the size. The success with which this objective has been attained is shown by the deflection under a 100% overload test which was less than that normally encountered in riveted construction.

There are other features incorporated in the design of this crane which are not, strictly speaking, connected with the arc welding story, but which are nevertheless novel. Among these is the use of roller bearings throughout for bridge wheels as well as for the trolley travel and hoist mechanism.

Another innovation is the manner of attaching the bridge girder to the end trucks, being secured in place by bolts. (The usual practice is for the bridge girders

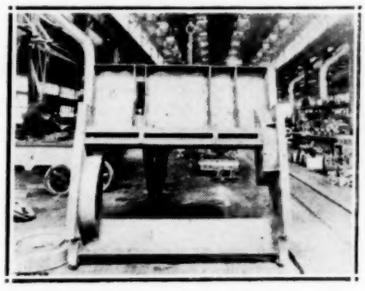

FIG. 5—Bottom view of trolley showing method of tying side frames and the reinforcement under top plate.

to rest on top of the end trucks). These bolts are in shear and any movement between bridge girders and end trucks tends to loosen the bolts. This tendency is avoided in the design of this crane by what is termed notch construction. The girders are fastened both to the top and to the side of the end trucks. Necessarily this connection must be made in the field because of shipping limitations and for that reason bolts are used.

However this design, which provides that at least half of the bolts will be in tension (instead of all in shear as is ordinarily true), insures a very rigid tie. In many cases of course this connection will be field welded, and in fact this practice is recommended by Cleveland Crane engineers.

The end trucks themselves are of box section completely arc-welded.

The side members are standard rolled channels connected by top and bottom cover plates with stiffening diaphragms. Roller bearings on the bridge wheel axles contribute materially to easy operation and permit very rapid acceleration under full load. Likewise the power consumption is decreased by 50% because of the reduction in bearing friction.

It is in the trolley itself that the greatest advantages of arc-welded construction have been realized. Here it was possible to save considerable weight and at the same time obtain greater rigidity and strength. The trolley is of all structural steel construction. The side members are standard channels. The bed for the hoist and trolley travel mechanism is flat plate with reinforcing plates arc welded under bearing points. The entire trolley frame is arc welded into one integral piece and proper placement of the reinforcement insures permanent positive alignment of all shafts and bearings.

Wherever pads and bosses are required to form seats for the hoist and travel mechanism, these are made by welding steel plate of the required dimensions to the structural parts of the trolley. In this manner machining is simplified and there is no necessity for weakening structural parts by removing the tough surface of the load carrying members.

The saving in weight on this type of trolley plus the use of roller bearings on the trolley wheels makes it possible to use a smaller trolley travel motor and at the same time to get faster trolley acceleration than with trolleys of conventional type. In fact before the motors were installed it was possible for one man to push the trolley along the bridge with a minimum of effort.

Tests made at the plant of The Cleveland Crane & Engineering Co. have amply justified the faith of Cleveland engineers in arc-welded construction. This crane was designed from the start for arc welding and thus savings were possible which could not have been made if customary riveted details were followed. The elimination of laying out of rivet holes, punching and reaming, driving rivets as well as some material saving all contributed to saving in manufacturing costs.

Needless to say, other details not described above, such as line shaft brackets, cross walk supports and bridge drive machinery brackets are all arc welded.

Mr. Wehr refused to predict how soon arc welding will generally supersede riveting in crane construction but stated that he would have no hesitancy in undertaking a 100-ton completely arc-welded steel mill crane.

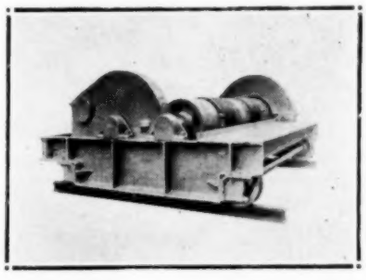

FIG. 6—The completed trolley. Note reinforcement under bearing points.

"In fact," concluded Mr. Wehr, "it was the ever increasing application of arc welding in steel mill crane service that convinced us that industry is ready to accept arc-welded equipment of this nature."

Figure 1. shows the conventional method of construction of a riveted box-section crane girder. Reinforcing angles at each of the four corners of the girder are used to fasten the webs to the cover plates by means of a single row of rivets. This construction gives a two-point connection between the webs and cover plates.

In the arc-welded construction illustrated in figure 2. a three-point connection is secured. Cover plates are joined to webs first, by a fillet weld running the entire length of the girder. In addition to this a reinforcing bar is welded both to the web and to the cover plate. This weld is continuous for 60 inches from

each end of the girder and the intervening distance is tack welded at intervals of 3 inches by welds 4 inches long. This construction gives a three-point connection and largely accounts for the extreme rigidity of the girder.

A second important advantage is that greater resistance to side strains can be secured with the same weight of metal by arc-welded construction. This is true because it is possible to space the webs further apart (distance A in sketch) using the same width cover plate. The reinforcing bar, while it has the same cross-sectional area occupies less space than the reinforcing angle and consequently can be located nearer the edge of the cover plates.

Discussion: Steam Connection to Damper Regulators

By J. J. NEVILLE*

IN the August issue of the Iron and Steel Engineer, there was an article on, "General Requirements for Safety." With reference to the part of that article under the heading, "Boiler Plants," on paragraph number twenty-seven (27), page 375, marked, "Damper Regulators," I would question their method of connecting, steam connection from boiler to the damper regulator.

The article states that if damper regulators and non-return valves are both used, that the steam connection to the regulator should be made to several boilers between non-return valves and boilers. The reason given for connecting regulator steam connection in this manner, is that, if the steam connection was on the main steam header, a break occuring on this header would mean a drop in the steam pressure, the closing of the non-return valves resulting from this break, the regulator would function to open dampers, thus putting full draft on boilers with the main valves closed.

My contention is, that the steam connection for a damper regulator should be taken from the point on the main steam system where the average boiler pressure will be obtained at all times under all loads, taking into consideration, the safety first rule, cost of installation and principles of regulation. This connection would not be, between the non-return valve and the boiler. Only under one condition would I make connection in this manner and that would be under direct orders of the man in charge of boiler room, these orders would be carried out under protest.

Assume first, that the steam connection to regulator is on main steam header. If break occurs on header line, non-return valves close, if steam pressure was low, the damper regulator would be open. Non-return valves being closed the pressure would build up, pop valves would take care of this condition. If when the break would occure steam pressure was high, pressure would drop, regulator would go from an closed to an open position. Pop valves would also take care of this condition.

Now we will assume that the boiler dampers are hand regulated. A break occurs on steam line, non-return valve cuts boiler off line, if damper was open when break occured, full draft would be on boiler, pressure would build up and pop valve would take care of excess pressure. If damper was closed, practically speaking, same condition would happen.

Whether boilers were automatically regulated or hand regulated, if a break occured on main steam line, boiler room attendants would shut off steam pressure on broken line as quick in one case as they would in another.

Take for example, the steam connection to regulator from several boilers from between the non-return valves and boilers. There could not be any check valves in the steam line to the regulator. One of these boilers, that regulator is connected to, is down for cleaning or repairs. The steam line to regulator not having a check valve in line, (because if it had, due to steam pressure balancing a weight on a lever by means of a diaphram, or steam pressure balancing a head of mercury, steam pressure in both cases acting through water column, this water column changing in accordance with the change in steam pressure, this change being prevented by check valve in one direction), would have to be shut off by means of a hand operated valve. You would have to depend upon the human element. If this valve was not shut off when boiler was down, the pressure on the regulator steam line would be released into this dead boiler. Another bad feature of this hookup would be, that if boiler was down, hand operated valve on steam line from this boiler to regulator being closed, there is a possibility that when a man was in the drum in this boiler a man on the outside of boiler not knowing that there was a man inside of boiler might turn on hand operated valve scalding man inside boiler.

The proper place to connect regulator (no matter whose make) would be on the main steam header where steam pressure corresponds with boiler gauge pressure plus difference in water leg pressure either plus or minus, regardless of load.

The only reason for connecting steam pressure to regulator other than from the main steam header would be, that if the steam pressure in the main header would vary with the load demand on boilers, there would be no use in connecting to steam header. The place then for steam connection to the regulator from boiler would be on the boiler gooseneck, between the non-return and steam header. With this method of hookup, you would have safety, because, if boiler was down, the boiler non-return valve would have boiler off the line. If there was a break in the steam line at some place away from the boiler the non-return valve would cut out boiler and the pop valve would take care of any built up pressure.

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*Formerly Asst. Supt. of Power, N. K. Fairbanks Co., Chicago, Ill.

Items of Interest

Scale Drawings Folio. Electrical draftsmen will be interested in the seven page folio giving scale drawing of high tension equipment. These seven engineering sheets give scales of ⅛", 3/16", ¼", ⅜", ½", ¾" and 1" to the foot. These sheets will be found very useful in making out substation layouts and copies will be mailed upon request. Write Delta-Star Electric Company, Chicago, Ill.

The Martindale Electric Co., 1256 W. 4th St., Cleveland, O. (manufacturers, manufacturers' agents and importers of Martindale Motor Maintenance Equipment products), have recently opened a branch in New York City, in charge of E. H. Mitcham, No. 6, East 46th St.

The booklet published under the title of "Protect the Joint and Save the Setting," by the Johns-Manville Corporation, will be of interest to all users of refractory materials.

As temperatures have increased the operating conditions of settings have become more severe. This requires a careful and scientific study of firing conditions throughout the manufacturing world. The Johns-Manville Corporation, manufacturers of refractory cements, have done this and the results are contained in their little booklet.

This booklet contains specifications for settings used by all branches of industry. These include boilers, gas generators, steel mills, iron and brass foundries, the oil industry, glass works, kilns of all kinds, incinerators, and locomotives.

Every engineer who aspires to keep abreast of the times should have a copy of this book.

Mr. C. A. Reed, formerly with the Combustion Engineering Co., at Pittsburgh, has accepted a position with the Erie City Iron Works as District Manager of the Pittsburgh Territory, with offices located at 1230 Park Bldg., Pittsburgh, Pa.

The Trumbull Electric Mfg. Co., Plainville, Conn., announce their new type Single Fuse Unit Panelboard, having lugs in the mains, tumbler switches and plug fuses in the branches, all of which are described in the September Issue of the "Trumbull Cheer," copy of which will be mailed to you upon request.

The Hyatt Roller Bearing Co. recently issued a very attractive flyer showing the application of Hyatt bearings to heavy duty steel mill applications. The Hyatt Roller Bearing Co. at Newark, Pittsburgh, Chicago, Detroit, Philadelphia, Worcester, Cleveland, and Oakland will be glad to mail you a copy upon application.

The Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio, has just issued a very attractive booklet to the trade known as Bulletin 102. This booklet describes the "Type AA Fully Enclosed Fan Cooled Reliance Induction Motors" with Ball Bearings. It is claimed that these motors are for use where motors are exposed to dirt, iron dust and moisture. The Reliance Electric & Engineering Co. will be glad to mail you a copy of this bulletin upon request.

The Martindale Electric Company, 1256 West 4th Street, Cleveland, Ohio, announces a bulletin describing complete Electric Portable and Stationary Heaters and Electric Strip Heaters.

General Electric announces a new line of motors for portable electric hoists and suitable also for other applications involving intermittent operation and high starting torque. The line runs from one to ten horsepower in the direct-current types; from one to eleven horsepower, single speed, 3 and 2 phase, and from one to five horsepower, single phase, in the alternating-current types. Three and two-phase, slip-ring type hoist motors are also included from three horsepower up.

The new motors are totally enclosed and all parts are well protected. Bearings are of the waste-packed, sleeve type, being closed against the entrance of dirt from the outside. The direct-current motors are series wound. The alternating-current motors of the polyphase type have high-resistance rotors, while the single-phase motors have an unusually high starting torque.

In a great many of the applications of these motors a brake is required. Accordingly the motors are all built with the shaft extension away from the drive to take a brake, and the motor end-shield at this end is fitted with pads or bosses with drilled and tapped holes for mounting the brake.

O. C. Callow has become associated with Freyn Engineering Company in the role of Assistant Electrical Engineer.

Mr. Callow is a native of England where he received his schooling and his early training in the British Westinghouse Electric & Mfg. Co. at Manchester.

Coming to Canada, Mr. Callow first became Electrical Superintendent in a cement mill. Following a period of service with the Westinghouse Electric & Mfg. Co., he entered the employ of the Steel & Tube Company of America at its Indiana Harbor plant. Here he spent a number of years both in the electrical engineering and operating departments. During this period much of the Indiana Harbor plant was constructed and placed in operation.

In 1920 Mr. Callow accepted the position of Electrical Superintendent with the Trumbull-Cliffs Furnace Company at Warren, Ohio, where he was identified with the construction of the blast furnace, power plant and coke oven plant. He leaves this connection to take up his new work in Chicago. The change also forces his resignation as Chairman of the Cleveland section of the Association of Iron & Steel Electrical Engineers.

An arc-welded, rivetless steel railroad bridge, the first of its kind to be built, is to be erected on the line of the Boston & Maine Railroad at Chicopee Falls, Mass., according to an announcement by Gilbert D. Fish, consulting structural engineer for the Westinghouse Electric and Manufacturing Company.

"Contracts for this revolutionary type of railroad bridge have been signed," said Mr. Fish, "and construction will proceed at once—completion is expected about January 1st.

"The Bridge, when finished, will be practically a one-piece structure since every joint will be welded solid and immovable. Weaknesses due to movable joints and rivet holes are thereby eliminated. As a result, the welded bridge is lighter than a corresponding riveted bridge to carry the same load and costs less. A longer life is also expected, particularly in the case of the floor construction.

"Only 80 tons of steel are needed for the welded job," said Mr. Fish, "whereas 120 tons would be necessary if the job were riveted."

The bridge, which is to be 175 feet long, will span a water-power canal at Chicopee Falls, Mass., and will connect the local Westinghouse plant with the Boston & Maine Railroad, thereby eliminating trucking to the freight station. It is being constructed by the Westinghouse Company with the co-operation and approval of the Boston & Maine Railroad. The Palmer Steel Company, of Chicopee Falls, will fabricate the steel and do the welding, and Tarbell and Leete, also of Chicopee Falls, will erect the foundations and steel work.

While the arc welding process as applied to a railroad bridge is new, there is nothing experimental in it, according to Mr. Fish. The Westinghouse Company has made exhaustive tests on arc-welded steel joints and has erected several buildings with arc welding and tested the resulting structures. "No doubt remains that arc welded joints can be made stronger than riveted ones," said Mr. Fish.

A compound wound 200 hp. direct current motor was recently started in a steel mill driving a large circular rail saw. This motor was found to surge up and down 30 rpm. about its normal speed.

The field was checked to see that the series field was cumulative by running the motor first as a series motor and then as a shunt motor—rotation was the same under both conditions.

It was noticed by sighting along the direct current brush holders with respect to the center of the main pole that the brushes had slipped off neutral, being moved in the direction of rotation a little over one bar. They were moved back to neutral position, which in this case was indicated by a dowel, and the motor immediately settled down and ran with uniform speed, even at high speed.

Due to the brushes being in advance of neutral, the inter-poles were acting as a differential series field, thereby weakening the main field flux with the result that the motor had a tendency to race. The windage losses in the circular saw immediately checked this and thus the speed surged up and down due to this unstable condition.

When the commutating coils are directly under the inter-poles (brushes being on neutral) they have no influence on the speed. If the brushes were back of rotation, the motor would have been stable, but its regulation would have been bad, since under this condition the inter-poles would aid the main poles.

The Roller-Smith Company, 233 Broadway, New York City, announces the appointment of the D. H. Braymer Equipment Company, W. O. W. Building, Omaha, Nebraska, as its representative for Nebraska and Western Iowa. Mr. D. H. Braymer is at the head of this organization. The D. H. Braymer Equipment Company will handle Roller-Smith instruments, relays and circuit breakers in the territory specified.

International Combustion Engineering Corporation announces the closing of a contract by its subsidiary, Combustion Engineering Corporation with the Kansas City Power & Light Company for two complete steam generating units for the Northeast Station. Each of these units will deliver 250,000 pounds of steam per hour continuously.

The boilers are designed for 1400 pounds pressure, which is said to be the highest operating pressure in use today. The contract includes Lopulco Unit Systems for burning pulverized fuel, water cooled furnaces, economizers and air preheaters, all manufactured by Combustion Engineering Corporation.

This contract closely follows one awarded to Combustion Engineering Corporation in August for the Grand Avenue Station of the Kansas City Power & Light Company, covering three units of 225,000 pounds capacity, complete with stokers, and, designed to operate at 700 pounds pressure.

Forty boilers are now installed at the Grand Avenue Station. The three new units are to have a total steaming capacity equal to more than half that of the entire existing plant.

The Joliet Works of the Illinois Steel Company, in their October Issue, "The Mixer," reports 192 days, 3,871,909 hours, 2560 men "NO LOST TIME ACCIDENTS." This is a six months' perfect record and is indeed a most remarkable attainment for a steel plant.

It might be well for the Association of Iron & Steel Electrical Engineers to hold a safety congress at this plant.

The Bridegport Brass Company at Bridgeport, Conn., has installed two automatic cleaning and pickling machines on which electric control is applied for the first time to govern the various steps in the process. The machines in question not only eliminate several men from the department, but also provide greater production at less cost.

Carriers on an endless chain convey the work to be cleaned and pickled from a filling station, through the various baths, to an unloading station. General Electric motors and control are used. On pressing a button, the carriers move from one position to the next and stop. After a predetermined time all carriers move to the next position. The time elapsing between moves is determined by setting a timing

relay; one machine operates on a 70-second cycle, and the other, on a 20-second cycle.

The automatic starting, conveying and stopping on such machines has usually been accomplished, in previous installations, by the use of an intermittent gear. In the present instance, electric control is used. In the mechanical method, the intermittent gear receives the brunt of the shock with the result that it becomes a probable trouble center. By using electric control of the driving motor, more of a cushion effect is obtained and less strain and jar are transmitted to the machine.

The machine described was built by the U. S. Galvanizing and Plating Equipment Company, of Brooklyn, N. Y., and the electric equipment is of General Electric manufacture.

A new low speed synchronous motor, called the type HR, has recently been placed on the market by the Westinghouse Electric and Manufacturing Company. This motor is the most modern and highly developed drive yet devised for slow speed machinery where direct connection is applicable. While arc-welding has been used to some extent in Westinghouse motors for 15 years, it reaches its greatest application in this motor. Its parts have been specially designed for ease in handling and ease in assembling in the field.

This motor has been designed for high efficiency at all loads within its normal operating range. High efficiency at fractional loads is a great power saver since few applications require the maximum output of the motor. The excitation has been materially reduced, thus increasing the efficiency and cutting operating costs. A difference of 1% in efficiency on a 200 hp. motor running 24 hours a day for 250 days a year means a difference of $250 with power at 3 cents a kw.

A starting torque of 50% and a pull in torque of 40% are features of this new motor. The higher the starting torque, the quicker the motor will come up to normal running synchronous speed. The disturbance on the line is correspondingly reduced. This higher-than-usual torque is also a valuable asset under such unusual conditions as starting a machine while it is still new and stiff or after it has been standing for a considerable time.

Low speed motors naturally have very little windage effect so that cooling is effected largely by radiation. As heat has a deteriorating effect on insulation, a cool running motor will have a long life. The shape of the rotor arms in this new motor is such that a large amount of air is set in motion. This cooling air is so directed that it not only passes through the stator coils but it also passes over a large area of the stator laminations as well.

A means of varying the flywheel effect is an attractive feature of the new, type HR, synchronous motor. By means of different weight rings bolted to the rotor rim, six possible values of flywheel effect are available.

Phoenixville, Pa.—The Phoenix Iron Company have developed the most completely successful "one-man" outfit that can be imagined: not having the success of the so-called one-man top which requires several men to fold or unfold, nor that of the one-man street car which fails to give the desired snappy service, but an outfit that honestly performs the duties of several men with as much agility as when those men were on the job. One man is crane operator, lifting magnet operator and furnace charger.

What would you call this one-man outfit? It consists of an overhead crane 60 feet long that spans the width of the mill building, an automatic control board hidden away in the power house, a lifting magnet of the bipolar type specially designed for handling steel billets, and a control box containing a row of push buttons mounted like the bass notes of an accordian and carried by a strap hung around the neck of the operator, much like an accordian is carried. Quite important, too, is the long steel handle reaching out from the magnet.

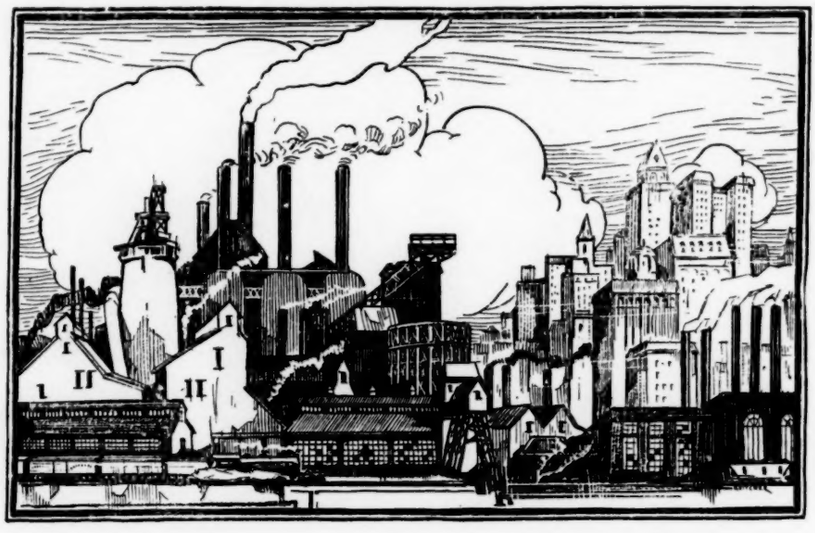
Occupying the center of this building in the plant of The Phoenix Iron Company, is a continuous heating furnace through which steel billets move slowly as they are heated for the rolling mill. When a hot billet is taken out of the furnace at the discharge end, a cold one is fed in at the other end and it is the job of this new equipment to keep the loading platform filled.

Watch this one-man outfit at work. To the left of the furnace stands a carload of billets just brought in from storage. With one hand playing on the keyboard slung across his chest and with the other on the handle attached to the lifting magnet, the operator walks toward the billets on the car, turning the magnet parallel to their length as he does so. Exactly at the middle of a billet, the magnet drops and you hear the sing of the metal as it takes hold. Then backing away and turning, he brings the magnet over the loading platform and drops the billet next in line at the heating furnace.

Eight men, four on each turn, have been eliminated since this billet handling magnet and crane were installed, saving the wages of these eight men. Eight men have been released for productive labor elsewhere by this group of equipment. Here is how it operates:

The three ton Shepard crane is fixed in its position above the end of the furnace, but the trolley from which EC&M Bipolar Lifting Magnet is suspended moves across the full length of the sixty-foot span. A 2.6 HP motor drives this trolley while a 10 HP motor is on the hoist. Control of the crane movements and the magnet are centralized in the line of buttons carried across the operator's chest. Three pairs of push buttons are mounted in this case, one pair for controlling the lifting magnet and the other two for the crane control.

For the sake of safety, the four buttons that control the crane are momentary contact buttons, making contact only as long as the operator is pressing on them. The instant he presses one of these buttons, power is connected to the corresponding motor and that motor is automatically accelerated to full speed by the EC&M Control Board in the power house. The acceleration of both motors of the crane, forward and backward, is handled through this automatic switchboard. Mounted on the same board is the contactor which connects power to the lifting magnet.



The Selection of Factory Sites

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Electric service furnished by a central station company is superior in quality and reliability. Last year 21 isolated power plants in the Pittsburgh District were abandoned and their service replaced by Duquesne Light Company Service.

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